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M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

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THE supply of copies of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, is entirely exhausted. As we need a few, any subscriber who may have a copy of that date, and who does not preserve his files, will confer a favor upon the JOURNAL by sending it to the office. For any copy of that issue sent in, the sender will receive a credit of *two months* on his current subscription.

THE latest tunnel plan proposed is to connect Scotland and Ireland. The projector, Mr. Barton, proposes to start from a point on the coast of Wigtonshire and to run under the North Channel to a point on Magee Island. The distance under water is 33 miles and the greatest depth below sea-level would be 500 ft., the steepest gradient 1 in 75. Such examination of the bottom of the channel as has been possible shows, it is said, that it is very favorable for a tunnel, and the undertaking has the support of some eminent engineers. Its total cost is estimated at $40,000,000, and it would take 10 or 12 years to complete it. The great difficulty seems to be the question of ventilating so long a stretch of tunnel where no air-shafts are possible.

THE Russian Government proposes to devote a considerable amount to the improvement of the interior waterways. The first work to be done is on the Marie Canal system, which was originally intended to connect St. Petersburg with the Volga, but which has been of late years much neglected. This system consists of a number of short canals and of river channels, and it is now proposed to repair and enlarge the existing locks and dams and to deepen, widen and strengthen the channels. Other improvements are to be made with a view of accommodating the increasing traffic of the Volga, the Don, the Vistula, and other rivers, especially the Volga. There are not many canals in Russia, and most of them are short and built to connect the river systems; but the country possesses nearly 34,000 miles of navigable rivers, and some of them carry a very large commerce.

A proposition lately made is for a canal to connect Lake Onega with the White Sea near Archangel. This canal would have a length of about 160 miles, of which about 70 miles is already natural water-way, and it would, it is believed, benefit very much the northern provinces adjacent to the White Sea.

ACCORDING to a recent report the whole length of Russian Railroads is 17,693 miles, of which about one-fourth belongs to the Government. This includes only the lines in European Russia, and in addition to those may be counted the railroads of Finland, 1,135 miles, and the Trans-Caspian Line, 661 miles. The principal addition last year was the Pskov-Riga Line, 245 miles, and some shorter branches, amounting to about 50 miles in all.

THE consumption of wood for ties is attracting much attention in France, and the railroad companies are urged to employ metallic ties to a greater extent than they have heretofore done. The present demand for wooden ties exceeds the quantity which can be supplied from the forests of the country, and a large number have to be imported at considerable cost. Two or three of the great French companies have used steel ties and are increasing the number in their tracks, but the others have not heretofore favored the metallic ties.

THE New York Aqueduct Commission has decided to accept Chief Engineer Fteley's plan for the dam and reservoir which is to replace the present Croton Dam. This plan, as noted in our last number, is for the construction of a dam about a mile below the present one, which will make a reservoir about one-half the capacity of the proposed dam at Quaker Bridge, which has been so much discussed. The new Croton Dam will cost considerably less than half the amount estimated for the Quaker Bridge Dam, and can be built in a much shorter time, while it is considered that the storage capacity provided will be sufficient for the needs of the city for 20 years to come.

A CORRESPONDENT of the *American Manufacturer* calls attention to the opportunity for introducing small

American steamboats on the Amazon River. The navigation of that river is at present mainly in English hands, and all the larger boats were built in England and are operated by Englishmen, but it is believed that there is room for a number of smaller boats of American construction to serve as feeders for the main lines.

IN a paper recently presented before the New York Electrical Society, Lieutenant Bradley A. Fiske, who is well known from his work in connection with electrical ship appliances in the Navy, calls attention to the need of electrical engineers in time of war not only in the Navy, but for handling the apparatus used in forts and for harbor defenses. He believes that in case of war it would be very difficult to fill the demand, and advocates the formation of corps of naval and military electricians to assist the regular Army and Navy in its work. Such a corps, he thinks, might exist in every large seaport town, and might be accepted as a regular part of the National Guard in the same way as the Naval Reserve has been organized in New York and Massachusetts. With proper assistance from the Navy Department these electrical companies might be extremely useful, and there seems to be no reason why they should not be organized and receive the support of the Government.

THE Census Bureau reports that the total production of steel in the United States in the year ending June 30, 1890, was 4,466,926 tons, or more than four times the production in 1880. About 85 per cent. of the total—3,788,572 tons—was Bessemer steel; 504,351 tons were open-hearth steel; 85,536 tons crucible steel; 83,963 tons were made by the Clapp-Griffiths process, and 4,504 tons by the Robert process. Steel works are now located in 19 States, Pennsylvania having the leading place, with about 62 per cent. of the total production. Illinois is second in rank and Ohio third. In the last 10 years crucible steel has shown but a small growth, but the increase in Bessemer and open-hearth steel has been extraordinary. Nearly half the total steel made last year was converted into rails, but the increase in the use of steel for architectural and other purposes has been very marked.

THE most important engineering work now in progress in the vicinity of New York is the new elevated line of the Pennsylvania Railroad in Jersey City, where the Company is building practically an entirely new line from the east end of the cut through Bergen Hill to the station at the ferry. The new line, which is for passenger traffic only, will have when completed four tracks, and will pass part of the way through Jersey City on an embankment varying in height and enclosed between heavy walls of masonry, while for the rest of the distance it is carried on an elevated structure of iron, consisting of heavy plate girders supported by iron columns, with bridges across the streets.

In connection with this, the Company is building an entirely new passenger station in Jersey City, which will be elevated some 15 ft. above the street-level. The train-house in this station will be 256 ft. wide and 600 ft. long, and there will be ample waiting-rooms and other accommodations. Passengers will not be required to descend to the street level, as all the Company's ferry-boats are to be provided with an upper deck, upon which they can pass from the station, while the necessary alterations will be made in the ferry-houses in New York also, so that passengers on leaving the boats will pass through the second story of the ferry-house and cross West Street on bridges before descending to the street level.

The expense of this elevation of the road is considerably increased from the fact that it was necessary to build the new structure without interfering with the running of trains upon the old, the plan adopted being to build half the structure at a time, so that two tracks can be used before the old tracks are removed. Much of the structure also has to be founded upon piles, as for some distance back from the water front the ground has been filled in and does not give a solid foundation. At the ferry, for instance, water was found 6 ft. below the surface, and it was necessary to use piles 50 ft. in length.

The change will be a great improvement both for the railroad and the city, as it will obviate the inconvenience heretofore caused by the constant passage of trains across some of the principal streets. In making the improvement it was necessary to secure the consent of the city to the closing of one street, but all the rest will be crossed by bridges, and will be free from gates or other obstructions.

CONSIDERABLE attention has recently been drawn abroad to the Servé ribbed boiler tube, a French invention which was described and illustrated in the JOURNAL for May, 1887, at which time some remarkable figures were given showing the increase in heating surface obtained by these devices. At a recent trial made at the Atlas Steel Works, Sheffield, England, two boilers of exactly the same dimensions were tried, one fitted with ordinary tubes and the other with ribbed tubes, both being kept at the same pressure and run under similar conditions. The trials averaged in length from 3 to 12 hours, and the results show an economy in fuel of from 14 to 16 per cent. in favor of the ribbed tube. On one 12-hour trial the results show for the boiler with the Servé tube 11.03 lbs. of water evaporated per pound of coal against 9.50 lbs. for the boiler with plain tubes. The Servé tube has been used in a set of boilers just completed in Glasgow for a steamer, and will receive the severe test of a voyage to Hong-Kong and return. In France this ribbed tube has been adopted for several steamers, and the Paris, Lyons & Mediterranean Company has decided to introduce them on 40 of its locomotives.

THE city of Memphis, Tenn., formerly noted for its bad sanitary condition, has been improved in an extraordinary degree, partly by an improved system of sewerage, but chiefly by a supply of pure water. The city water was formerly drawn from wells and cisterns and later from Wolf River, but in both cases the surface water which yielded the supply was of very poor quality and contained many impurities, making it unfit for use and a constant cause of disease. Recourse was at last had to artesian wells, and it was found that at a depth of about 350 ft. there was a stratum of water-bearing gravel, the water being of exceptional purity, and abundant in quantity.

The city supply is now drawn entirely from these wells, and the works present many points of interest. The water-works draw their supply from 32 deep wells, which discharge into a tunnel, an arrangement adopted to prevent any influx of surface water. This tunnel is about 3,000 ft. long, is lined with brick and conducts the water

to a large well at the pumping works, from which it is pumped up and into the supply pipes.

The quantity of water is abundant for all present needs, and it is believed that any future increase in requirements can be met by increasing the number of wells. The geological formation of the country indicates that the water-bearing gravel is supplied from the hills of Middle Tennessee, where the rainfall is free from contamination, while the water is further subjected to a filtering process by the gravel through which it works its way.

THERE seems to be an especial field for the application of electricity in mining, where it is of great importance to be able to apply power without interfering with the supply of air. Hence the electric motor presents great advantages for hauling in mines, for operating drills and other machinery, running ventilating fans and similar purposes.

Electrical engineers have realized this, and have already paid much attention to the subject, with excellent results. This was seen at the recent meetings of the American Institute of Mining Engineers, and the British Iron & Steel Institute, at which several papers of much interest on electrical work in mines were read.

Others papers presented at the same time covered what may be called the purely metallurgical applications of electricity, such as electrical welding, separation of ores and other similar matters.

THE Ohio & Mississippi is one of the few railroads which can show an increase in average freight rates in recent years. For nine years past the average rate has been, in cents per ton-mile :

Year.	*Cents.*	*Year.*	*Cents.*	*Year.*	*Cents.*
1881–82	1.17	1884–85	0.81	1887–88	0.76
1882–83	1.00	1885–86	0.70	1888–89	0.81
1883–84	1.05	1886–87	0.72	1889–90	0.85

It will be seen that there has been a gradual increase for four years past, and that the rate last year showed a gain of 21½ per cent. over 1885–86, the lowest year. Last year's rate, however, still showed a decrease of 30 per cent. from that of 1881–82. The cause of this unusual gain is to be looked for chiefly in the increased proportion of local freight.

THE same complaint is heard in England that has more than once been made by our own Navy Department, and that is the difficulty of securing proper and competent men for the engineering department, especially in the lower grades. It is more felt abroad than here, chiefly on account of the greater number of vessels and consequently of men needed. Our own Navy has many well trained and thoroughly educated engineers in the higher grades, but engine-room artificers and mechanics are not to be found when nor in such numbers as are wanted.

One great cause doubtless is that competent men can earn as much or more ashore, where they are free from the restraints of naval discipline ; but another certainly is that sufficient inducements in point of rank and standing are not offered. The traditions of naval service are long-lived, and the subordination of the engineering staff to the sailor and the fighting man in the naval organization is almost as complete as in the days of the old sailing frigate and line-of-battle ship. But the modern war-ship is essentially an engineering structure, and one of so complicated a description that its successful management depends almost wholly on the engineering staff. When this is realized and a proper place accorded the engineer and his subordinates, the greater part of the trouble now existing will pass away.

A GREAT dam is to be built across the Colorado River near Austin, Tex. This dam will be 1,150 ft. long, extending from bluff to bluff, and 60 ft. high from foundation to crest. It will create an artificial lake some 30 miles long, principally by deepening the river which for some miles above the site chosen flows between high bluffs. The canal through which the water will be drawn to furnish power will start from a gate-house at one end of the dam and will extend about 1,000 ft. through solid rock. The reservoir will be drawn upon to furnish water for the city and also to supply the power for pumping this water and for supplying electric light, and it is expected that there will be a large surplus of power which can be furnished to manufacturing establishments which could be located on the power canal or its extensions. It might be added that here would be an excellent opportunity for testing again the electric transmission of power. Large dynamos erected at or near the dam could furnish power to any part of the city or its vicinity.

AN elevated railroad is proposed for Boston by the West End Company, which owns all the street railroads of the city. The plan provides for a line which will use some of the existing street and other places run through private property. The first section would extend from Roxbury through the central portion of Boston to Charlestown, and would be about five miles long. An extension or branch to South Boston would follow the construction of the first line. The road would be run by electricity in all probability, although details have not been worked out. The Company asks for some assistance from the city in securing property needed, and while the plans are under consideration no action will be taken on them for some time. There seems to be, however, a general opinion that an elevated road of some kind in Boston is a necessity.

RECENT floods in the Moldau River in Bohemia have partly demolished one of the oldest bridges in the world. This was the famous Karlsbrücke at Prague, the building of which was begun in 1357, though it was not completed in its present—or late—form until 1507. It was 1,620 ft. long, having 16 stone arches resting on ponderous piers, and was a very fine specimen of mediæval masonry. The floods undermined the piers in the center of the river, and finally three arches of the bridge fell, after successfully resisting the storms and floods of 380 years.

THE next International Geographical Congress, it is announced, will be held at Berne, Switzerland, in August, 1891. The Berne Geographical Society has undertaken the local arrangements and entertainment of the Congress. It is probable that this meeting will be of especial interest to American geographers.

AN interesting part of the work of the Coast Survey has been the location of the frontier line between Alaska and the British possessions. Two parties have been at work on the Porcupine and Upper Yukon rivers for two sum-

mers past, but the work has been necessarily slow, as there are many difficulties to contend with: the remoteness of the region, difficulties in obtaining supplies, shortness of the season in which work is possible at all, and—last summer especially—a very rainy season.

ON November 1, according to the tables of the *American Manufacturer*, there were in blast 342 furnaces with a weekly capacity of 180,455 tons, an increase of five furnaces and 3,672 tons capacity over October 1. As compared with November 1, 1889, the increase is 13 furnaces in blast and 17,738 tons weekly capacity. Thus the production of pig-iron continues very active and there is little doubt that the year 1889 will show a greater production than that of any previous year.

A REPORT comes from Siam by way of Burmah that the contract for the first Siamese Railroad, to which reference has heretofore been made in our columns, has been let to a German firm, and that the road will be built of German materials and stocked with German rolling stock. Some doubt seems to be attached to this, however, and further advices are needed to confirm it. In Oriental countries such matters move very slowly.

WATER SUPPLY IN NORTHERN NEW JERSEY.

FOR some years past a corporation known as the East Jersey Water Company has been engaged, either directly or through subsidiary corporations, in securing control of the water and water-rights in Northern New Jersey, which could be made tributary to its plans. The Company has also secured, it is understood, the co-operation of the Lehigh Valley Railroad Company, which is lessee of the Morris Canal, a corporation chartered many years ago, and owning valuable water-rights and rights of way through the section named. The object of the Company was to secure control of the water supply which, it was foreseen, would be needed for the rapidly growing towns and cities in that section of New Jersey which is adjacent to New York, and those plans have already begun to bear fruit. The first important contract made has been with the city of Newark, which has drawn its supply for a number of years from the Lower Passaic, but has, especially of late years, found that supply unsatisfactory, owing to the constantly increasing impurity of the water inevitable in a river running with a moderate current through a densely populated region, where many factories add their share to the household refuse which passes in the river. The supply which is to be furnished to the city will be drawn from the tributaries of the Upper Passaic, which drain a large water-shed in a mountainous and thinly settled country, where there can be very little pollution of the water, and where, moreover, the rivers are rapid mountain streams which quickly purify themselves of anything which they receive.

The Newark contract was originally made with the Lehigh Valley Company as lessee of the Morris Canal, but was assigned to the East Jersey Water Company, which has undertaken the task of laying the pipe and providing the necessary storage reservoirs. The contract is for a supply of 27,500,000 gals. per day. The pipe line will be about 30 miles in length, starting from a point on the Pequannock River about 850 ft. above sea-level. The aqueduct will be made of steel pipe, which is now being laid. It was at first proposed to use the Morris Canal as an open conduit, but that plan has been abandoned in favor of the pipe system. The line commences not far from Oak Ridge, and follows nearly the lines of the New York, Susquehanna & Western and the New York & Greenwood Lake railroads to the distributing reservoirs above Newark.

In order to secure a regular and satisfactory supply, the Company has begun the construction of three large dams and reservoirs, in which will be stored the flow of the Pequannock and its tributaries. The first of these dams will be located near Oak Ridge, and will convert the northern end of the Longwood Valley into an artificial lake, having a capacity of 2,500,000,000 gals. The dam will be 650 ft. long, 45 ft. high, 500 ft. thick at the base and 20 ft. at the top, and will be built of earth, with a concrete core some 16 ft. thick. This will receive the flow of the Pequannock and its upper tributaries, drawing the water from the watershed of the eastern slope of the Wallkill and Canisteer Mountains.

The second dam, which is not far from the village of Newfoundland, will be of about the same cross-section as the Oak Ridge dam, but will be 1,500 ft. in length, and the artificial lake here formed will have a storage capacity of 3,538,000,000 gals., and in this will be gathered the water from the more northern slope of the mountains, and of one of two important tributary streams.

The third dam, which will be four miles southeast of the second, will be placed at the outlet of Lake Macopin, and will be of masonry 25 ft. high, 15 ft. thick at the base and 8 ft. at the top, and 400 ft. long. It will increase the present size of the lake by filling the valley in which it lies, and this will be used rather as a distributing reservoir than for storing great quantities of water, as its capacity will be not much more than 160,000,000 gals. From this point water will be drawn for the pipe lines.

The Company's plans are not limited to the supply of Newark, but arrangements are already being made to introduce the water into Jersey City and Bayonne, which have heretofore drawn their supply from the Passaic and, like Newark, have found it very unsatisfactory. In fact, it is proposed eventually to supply all the towns and cities between the eastern slope of the Orange Mountain and the Hudson River, a district which contains not only several large manufacturing cities, but also a great number of rapidly growing towns and villages, and which, it is estimated, will contain a population of probably about 1,000,000 within a comparatively short period. With proper arrangements for storage and distribution there seems to be no reason why the varied and extensive water-shed of the Upper Passaic and its tributaries will not supply this population.

GERMAN WATER-WAYS.

THERE is no country in Europe which has made so much progress during recent years in the improvement of its internal water-ways as Germany. This is partly the result of the consolidation of government which took place some 20 years ago, but is more especially due to the efforts of the "Navigation Unions" which have been formed in a number of the principal cities with a leading

organization at Berlin. Their active and intelligent efforts secured the attention of the Government and have been continually devoted to interesting not only the Government, but the commercial bodies of the different cities.

The canal system of Germany is less extensive and perhaps less improved than that of France, but the length of navigable rivers is greater. So far the work done in recent years has been principally in improving the navigation of the rivers, and in providing port facilities at the commercial towns. Among the works so carried on are included the canalization of the Upper Oder; the canal connecting the Oder and the Spree; the canal from the Elbe to the Trave, and the canalization of the Maine from Frankfort to Mainz. The Oder-Spree Canal is not yet completed, but the work is well advanced, and work is also in progress on the ship canal which is to connect the North Sea with the Baltic. The last named, however, is principally a military work, which was undertaken with the primary object of connecting the two great arsenals and navy-yards at Kiel and Wilhelmshafn, although it will probably be of considerable service to commerce.

Among other projects which are now being pressed are the canal connecting Strasburg with the Rhine, the canalization of the Moselle and the canals from Magdeburg to the Elbe and from Dortmund to Emden.

All these works are being carried out by the Government, but while it provides a free water-way, the work of establishing ports and landings at the various commercial towns is left to local and private enterprise. At Hamburg, at Frankfort, and at other towns such works have been carried out on a great scale, and extensive basins and docks with complete facilities for loading and unloading have been provided. The effect of these works is evident in a very great increase of internal commerce on the various rivers, and in the beneficial results which the cheap transportation provided for coal, iron ore, and other freights have had upon the manufacturing industries. The railroads and the canals alike being under strict Government control in Germany, there has been no injurious competition for traffic, and it is claimed that the improvement of the navigation has in fact benefited rather than injured the railroads.

No transit tolls are charged on any of the German canals. The business of towing, however, is largely in the hands of companies, but is so conducted that the boats are able to carry freight at extremely low rates. Some of these boats belong to private owners, but a great many of them to the towing and transportation companies, and the system is found to work very well. The system of cable towage is in use for a long distance on the Elbe and in some other places, but its use does not seem to be extending, and on the smaller rivers and canals, where steam-tugs cannot be used, animal power seems to be still the main reliance.

THE ARCHITECT AND THE ENGINEER.

In England recently a noted writer made a violent attack on the Forth Bridge and its builders on account of the total lack of beauty in the structure; and later an American writer, in the *Popular Science Monthly*, criticised our architects severely because they are too much inclined to design buildings which are merely pretty, without regard to the use to which they are to be put, and to sacrifice the best design to outside show and ornament. Both have some reason in their comments, but the English critic the least. Mr. Morris is a poet and writer, and it seems impossible for him to take the engineer's view of the case. A structure like the Forth Bridge must be designed, first of all, with a view to its use as a bridge, and questions of taste or beauty find small chance for consideration. At worst it may be said of it, from an æsthetic point of view, that it is at least honest; it does not pretend to be anything else, and no feature of its proper use is sacrificed to ornament or merely pictorial effect. It may be imposing in its effect from its great size—as the Forth Bridge is—and in that case any attempt at ornament would weaken and impair the general effect. A bridge, although plainly and manifestly a bridge, as it should be, may nevertheless be far from marring the landscape, as Mr. Morris charges that the Forth Bridge does; the Poughkeepsie Bridge, for instance, as seen from the river below, is certainly a graceful structure, and really seems to harmonize with the natural surroundings, while the Brooklyn Bridge can hardly be called ugly or ungraceful.

On the other hand, Mr. Ferree's indictment against the architects has some counts which are not easy to disprove. There is a tendency to mere prettiness; there is a disposition to make buildings which will look well, without regard to the use to which they will be put. A Gothic window, an elaborately ornamented Byzantine or Renaissance doorway, are admirable in their proper places; but the architect who leads the passer to think that his building is a church when it is really a bank, the office of a machine shop, or a railroad station, is not to be commended, and that is not true art which builds the tower or stand-pipe of some city water works in imitation of an Italian *campanile*. Moreover, it is true in more than one notable case—and it is not necessary to go outside of New York or Chicago to find them—the real constructive strength of a great building has been sacrificed to appearances or to mere show, not deliberately perhaps, but really through ignorance and because the architect's training had led him to neglect the engineering side of his profession.

The fact is that here, as in many other cases, it is not easy to draw an exact line of demarcation between the two professions. It has been said that the engineer should be something of an architect; it may also be said that the modern architect should be a good deal of an engineer. The great size of some of our buildings and the amount of machinery needed to run them properly bring up questions which require no small amount of engineering skill to solve. The foundations of the Produce Exchange in New York, for instance, were nearly as difficult a work as those of the Brooklyn Bridge piers, and many similar cases could be cited; and an error in one would be about as costly and as troublesome in its consequences as in the other.

Our modern requirements are so extensive, however, and the range of knowledge to be covered is so great, that it is probably asking too much to expect a single man to master two professions; and while the architect should understand the fundamental principles of engineering, in all important structures an engineer ought to be called on to decide all special points and to assist the designer with his skill and experience. On the other side, the engineer should not be above asking the assistance of the architect, and considering, to as great an extent as possible, the outside appearance and general effect of his work.

In this way the balance may be preserved, and the result will be that our great buildings will not show either structural weakness or useless waste of material, and our railroad shops and other structures will not be distinguished by bare ugliness and a general lack of all appearance of design. Perfection is not to be expected in human work, but some improvement over much of our present work may be hoped for.

THE TENNESSEE RIVER IMPROVEMENTS.

AN important work now approaching completion is the canal which will enable steamboats to pass the obstructions known as the Mussel Shoals, and will complete the connection between the navigation on the upper and the lower Tennessee. This canal, which was first projected more than 60 years ago, was actually begun in 1875, and has been executed as rapidly as the appropriations made by Congress from year to year would permit, the work having been undertaken by the United States Government.

The Mussel Shoals proper, with the Little Mussel Shoals below them, are a series of rocky barriers or obstructions some 30 miles in length, which have prevented all navigation of the Tennessee River for a distance of over 40 miles. The whole improvement includes a canal 1¼ miles in length, with two locks, around the upper end of the barrier—known as the Elk River Shoals; the clearing out of the river channel for four miles above that canal and for eight miles, from the foot of the Elk River Shoals to the head of the Mussel Shoals proper; a canal 14½ miles long, with nine locks, around those shoals; and finally the cutting of a channel at the Little Mussel Shoals, 2½ miles long, through rock, with wing dams to regulate the current and preserve the channel.

The locks, which are 11 in number, as stated above, are all 300 ft. long and 60 ft. wide, and overcome a total fall of 134 ft. The canal has a uniform depth of 6 ft., its width varying from 70 to 120 ft., and is intended to pass steamboats of 5 ft. draft at any stage of the river. It has been built with great care, all precautions having been adopted to prevent damage by flood, and to avoid any interruption to navigation.

The most important structure on the canal is the viaduct which carries it over the mouth of Shoal Creek, not far from the foot of the canal. This viaduct is 860 ft. long, and is substantially a trough 60 ft. wide and 6 ft. deep, of steel plates, carried by steel girders, which are supported by abutments and 25 piers of masonry. There are thus 26 spans, averaging 30 ft.; 21 girders in each span carry the weight of the aqueduct.

The canal is now very nearly ready for the passage of boats; but to make it fully available it will be necessary to complete the channel at Colbert Shoals and Bee-tree Shoals, 21 and 25 miles below. At each of these a lock and dam are to be built and the channel cleared out. The dams will serve to keep a depth of at least 5 ft. in the channel in the dry season, and will finally open the navigation of the river from Knoxville in East Tennessee to the Ohio River.

The importance of this improvement will be seen when it is remembered that the Upper Tennessee and its tributaries flow through the coal fields and rich mineral regions of East Tennessee, and that barges loaded at Knoxville or Chattanooga will be able to carry their freight through without transfer to Memphis, Vicksburg or New Orleans. Having its sources in an extensive mountain and forest region, the Tennessee has a fuller and more uniform water supply than the Upper Ohio; and with the industrial growth of the region through which it flows, will doubtless become an equally great and important highway of commerce.

ENGLISH AND AMERICAN LOCOMOTIVES.

OUR distinguished English contemporary, the *Engineer* of November 7, contains another article on this subject, which is made up largely of data concerning the performance of English locomotives, the burden of which is to show that they evaporate more water per pound of coal than American locomotives do. There is not time before the December number of the JOURNAL goes to press to analyze the figures it gives, nor to compare them with those representing the performance of American locomotives. For the present, then, the only comment we will make is that as a question of economy, of locomotive performance, the rate of evaporation is only one of the elements. As we have pointed out before, a locomotive may show a high rate of evaporation, and at the same time the cost of locomotive service may also be high in proportion to the amount of work done. We may have something to say on this branch of the subject, and also on the rate of evaporation in American locomotives under different conditions hereafter.

Our contemporary is silent about the rate at which coal can be burned in English locomotives compared with that which we have shown repeatedly in common practice in American engines. Its only reference to this branch of the subject is a statement that, in some experiments made by Mr. Drummond, of the North British Railway, thirteen years ago, in which he burned 83 lbs. of coal per square foot of grate per hour. This is the highest rate of combustion that our contemporary has claimed for English locomotives. In a preceding number it said "about 75 lbs. may be regarded as our maximum." The rate of evaporation in American locomotives, as given by well authenticated reports quoted in these pages, is 119.3, 121.6, 133.2, 148.1, and 193.7 lbs. of coal per square foot of grate per hour. The *Engineer* says nothing about these figures. The facts which they represent certainly have an important bearing on the question under discussion.

As *Engineering News*, which originally entered into this discussion with much ardor, has announced that he or it "will not play any more," either we must change our position as an independent commentator, or the discussion must come to an end. Undoubtedly much will be lost to the world by the decision which the editor of the *News* has announced. Perhaps more truth will be evolved in a discussion of this kind, if one of the parties to it assumes the attitude of an engineering agnostic than if he is confident that truth and rightness is altogether and exclusively on his side.

The *Engineer* complains that the American technical press has not handled this important and interesting question with sufficient seriousness. In the language of Pope, slightly changed, it may be said of our contemporary:

> "Great was the cause; his old *solemnities*
> From no blind zeal or fond tradition rise."

It was, perhaps, thoughtless to joke on such an occasion.

It is said to be a flagrant breach of the code of true politeness to make use of words from a language which the person addressed does not understand. It is, perhaps, equally inconsiderate to discuss important subjects in a sportive way with those who are inclined to consider them solemnly. We will try to be very serious in discussing this subject hereafter.

THE LAUNCH OF THE "MAINE."

THE launch of the armored cruiser *Maine* at the New York Navy Yard, on November 18, attracted much public attention, and was witnessed not only by some of the chief officials of the Navy and the Army, as specially invited guests, but also by one of the largest assemblies of sight-seers that has been gathered about New York for a long time, including many well-known persons. Reference has been made to the *Maine* from time to time in our columns, and a brief description of the ship will be found on another page. The launch, it may be noted, was successful in every respect.

The launch of the *Maine* really deserved some attention, since it was in two ways a notable event. The vessels which have been completed thus far for the Navy are all of the unarmored cruiser type, swift ships, which can be made very useful in time of war, and which are excellent representatives of the country abroad in time of peace, but which are not adapted for heavy fighting or close quarters with an enemy's fleet. The *Maine* and the battle-ship *Texas*, which is now under construction at Norfolk, were the first fighting ships of modern design undertaken, and will be when completed the first ships in the Navy protected by heavy armor and carrying batteries which can be used with some chance of success against an armored antagonist. Moreover, the *Maine* and the *Texas* are the first steel ships of the new types to be built in the Government yards, and their construction is a test of the capacity of those yards for adaptation to modern plans and methods—a test which has so far shown excellent results.

The *Maine* is not by any means completed yet, as she has still to receive her engines and boilers, the side armor belt, the barbette armor, turrets, and masts; it will, in fact, be a year in all probability before she is ready to receive her armament and go into commission. Much of the work, especially that on the engines and boilers, is done, however, and there will be no delay in pushing the work forward.

The battle-ship *Texas* at the Norfolk yard, while not yet ready for launching, is making steady progress, and will not be much behind the *Maine* in getting ready for sea. By the time they are in commission the three battle-ships for which contracts were lately let will be well under way.

EDITORIAL NOTES IN PHILADELPHIA.

THERE is no place in the country in which a mechanical engineer will find so much to interest him as he will in this sober city on the Delaware. Manufacturing is there regarded as the most important interest in the community, and the most influential people are manufacturers, among whom the mechanical engineers take the lead. A visit to Philadelphia is therefore always interesting, and the following notes are intended as a sort of reflection of what was seen and heard there during a recent hasty visit to several of the large establishments for which that city is noted.

The first landing, so to speak, was made at the works of Bement, Miles & Company, the well-known makers of machine tools. This firm is making important extensions to its establishment, the buildings for which are now nearly completed, and when fully equipped will add very materially to its capacity for turning out work.

Before the present extension was made, the shops occupied about three-quarters of the block bounded by Callowhill, Twentieth, Twenty-first streets and Pennsylvania Avenue, shown in the plan, fig. 1. The remainder or eastern end, indicated generally by the area *A B C D E F*, was occupied by dwelling-houses, a coal-yard, etc. The buildings on this ground were pulled down, and the new extension of the works has been built in their place. This portion of the extension, as shown, is generally of an ⌊ form; the lower side of the ⌊ having 160 ft. on Callowhill Street, and the right-hand side 193 ft. on Twentieth Street. The building on this area is three stories high, and has what may be called two grand halls, which are open to the roof, and each has a Seller's traveling crane of 60 ft. span, 30 tons capacity, and 35 ft. lift. On the Callowhill Street side of the grand hall, *H*, are two galleries 24 ft. wide and on the Twentieth Street side of *G* two more, each 30 ft. wide—three stories in all—which are occupied by tools and machinery. These galleries are served by the cranes, and as they are connected with the foundry, as will be explained, and also with a railroad track and the packing department at the north or Pennsylvania Avenue end of *G*, they give the best of facilities for handling heavy and also comparatively light work. On the north side of *G* the boilers and engine are located, and above them are galleries similar to those on Twentieth Street. The tool and fixture-room is on the third story gallery, and is 30 × 105 ft. A drying-room for lumber is located over the boilers. These are new, of the Wharton-Harrison type of 400 H.P. The power will be supplied by a new compound high-pressure engine of 200 H.P., built by McIntosh, Seymour & Company, of Auburn, N. Y.

The new extension is all fire-proof, or of "slow burning" construction, and is admirably lighted from skylights of the "saw-tooth" form, in which the windows have only a northern exposure. It is remarkable how slowly those who have charge of the erection of new shops are in recognizing the advantages of a north light, as it excludes the sun, and the light is constant at all times of the day. The windows in the street sides of the buildings are ample in size, the walls on the inside next to the windows being flared, which increases very materially the amount of light admitted by them. It is singular, too, how slowly the advantages of this feature are in being recognized by those who build shops and houses. The shops will be equipped with a complete Edison electric plant for lighting. Three Otis elevators or lifts, not shown on the plan, will communicate with and serve the different galleries and stories in both the old and the new portions of the shops.

The long, narrow space indicated by *L* and extending from *J* to *K* was formerly a drive-way, and was bounded on the south side by the wall of the old machine-shop *M*. This wall has been taken down and the space roofed over, and two 20-ton Yale & Towne cranes of 50 ft. span have been erected in this space, and have a run of 210 ft. The old machine-shop is three stories high. By the removal of the north wall the different floors became galleries, which are served by the cranes in *L*. As the foundry is on the north side of *L*, these cranes give excellent facilities for handling castings and carrying them to any of the floors of the machine-shop, and thence to the erecting floors *H* and *G*. It is the intention ultimately to put in another pair of cranes alongside of those in *L*, and narrow the floors in *M* to the same width of the galleries on the Callowhill side of *H*.

A new building, 85 × 65 ft. and three stories high, indicated by *I* in the plan, has been erected on Pennsylvania Avenue adjoining the foundry, and between it and the new extension. The lower story of this will be used as a cleaning-room for castings, and is fitted with pickle tubs, cranes, etc. The second story will be used as a storeroom for finished tools and machinery, and the third as an extension of the pattern-shop.

N is the core-room, and *O* the core ovens. It will be seen that the cores can be put into the ovens from one side and delivered into the foundry on the other.

P is a large pattern storehouse built a few years ago, and is 190 × 40 ft. It is three stories high, entirely fireproof, and connects with the foundry by a large door from which the patterns can be handled by the foundry cranes.

Besides the shops which have been described, this firm are also using the old Machine Tool Works at the corner of Twenty-fourth and Wood streets, in which they build hydraulic and steam machinery and other heavy work. From 750 to 800 men are employed in both the shops, and

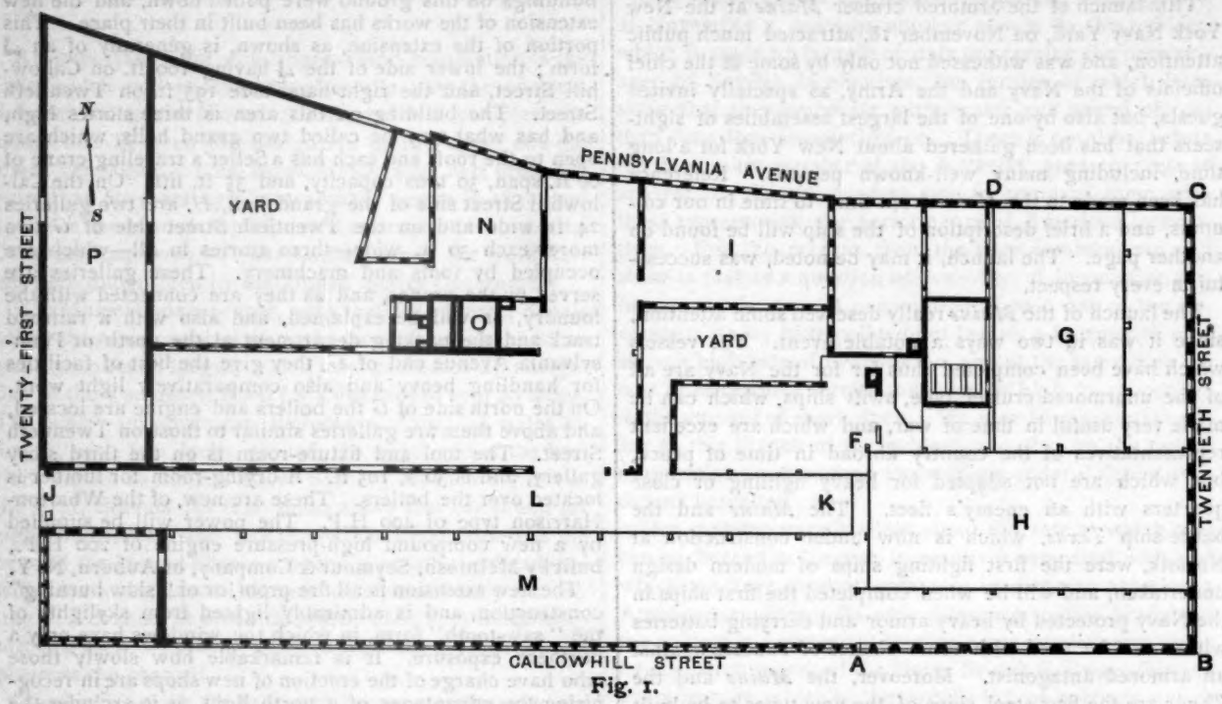


Fig. 1.

PLAN OF SHOPS OF BEMENT, MILES & COMPANY, PHILADELPHIA.

when the extension is completed about 100 more men may be employed. The new extension and plan will improve very much the facilities of the firm for handling all their work, but especially the heavy machinery which is now required by the Government and other large establishments.

WILLIAM SELLERS & COMPANY.

This firm has also added materially to its facilities for doing work. An extension 60 × 140 ft., with a 30-ton traveling crane, which lifts 32 ft. and is driven by an electric motor, has been built about a year. A second extension is now being built west of this and parallel to it. This will be 60 × 200 ft. Some of the old portions of the shop are to be removed to make room for it. It will also have a traveling crane for handling heavy work. It will have a span of 57 ft. and a capacity of 50 tons, and will lift 40 ft. A new floor is also being put into the erecting shop corner of Pennsylvania Avenue and Seventeenth Street, making two stories to the building. These extensions are being added to their works to enable them to complete large contracts for heavy work for the Government.

PEDRICK & AYER.

This firm has moved into the new shop on Hamilton Street within the past year. It is a four-story building 40 × 160 ft., with the boilers and dynamos in the basement. They are making a specialty of what they call their open-side planing and shaping machine, which is the invention of John Richards, of San Francisco, and has been improved by Mr. Edward A. Walker, in the employ of Messrs. Pedrick & Ayer. The peculiarity of this machine is that the work or the part to be planed stands still and the tool-holder moves. Consequently the weight of the piece to be planed is a matter of no importance in doing the work, as it stands still while the head carrying the tool does the work. They are building these of various sizes, the largest being 40 ft. long. They have furnished these planers to the Russian and German governments, to Sir William Armstrong's Elswick works in Newcastle, England, and about 20 are in use in this country.

They also make a specialty of a heavy universal milling machine. Their new pattern takes work 30 × 12 in. wide. They have recently shipped the sixty-eighth of these machines.

A cheap model of link-motion, to illustrate the principles and working of valve-gear to students, firemen, etc., has also been added to the list of machines they manufacture.

Their new shop is admirably arranged with excellent light, and gives them greatly increased facilities for doing work.

BALDWIN LOCOMOTIVE WORKS.

Very extensive alterations and additions to this establishment are also in progress, and part of them are completed, and are shown in the perspective view, fig. 2, which represents the buildings on the block bounded by Broad, Spring Garden, Fifteenth and Buttonwood streets. The office is at the right-hand corner at *A*, and extends to *B*. *B C D* is a new four-story shop, the plan of which is of the form of a letter L. This is completed and, as shown by the engraving, is four stories high, and is used for doing the work—such as fitting and bending pipes, polishing connecting-rods, sheet-iron work, etc.—which is incidental to the erection of locomotives. This building fronts from *D* to *C* 208 ft. on Fifteenth Street, and from *C* to *B* 228 ft. on Spring Garden. It is 60 ft. wide on Fifteenth and 48 ft. on Spring Garden.

E F G H is the new erecting shop, 336½ × 159 ft. It is divided lengthwise by a row of iron columns into two divisions or bays, as shown by fig. 3, which represents a cross-section of the building. Each division or bay has a 100-ton traveling crane built by Messrs. William Sellers & Company. The cranes have 74 ft. 8 in. span, measured from center to center of rails, and 28 ft. lift. Each crane has two trolleys of 50 tons capacity. The cranes will both be driven by electric motors. The purpose is to be

able to pick up the largest locomotive in any part of the shop and lift and move it to any other part with the same facility that a woman would transfer her baby from one part of the nursery to another. Although the engraving gives the building the appearance of having two stories, it is in reality open from the floor to the roof, so as to get sufficient height for handling locomotives and their different parts. This building when completed will be the finest erecting shop in the country, and probably in the world. The roof, as shown in the engravings, has skylights of the saw-tooth pattern, which admit light only on the north side and thus exclude sunshine, a method of construction which is very common in England, where they have little sunshine, but which has only recently been adopted here.

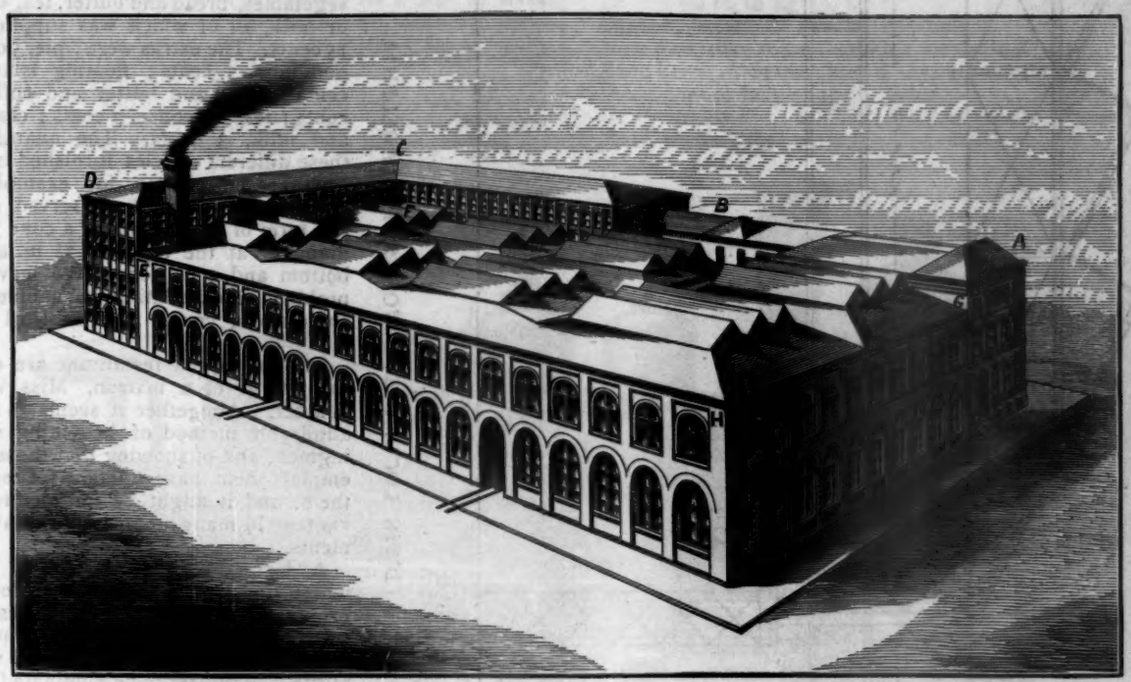


Fig. 2.

NEW SHOP OF THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

While in these shops an opportunity occurred of seeing the new method of turning tapered bolts, which has been devised by Mr. Vauclain, the Superintendent of the shops. The machine which is used for this purpose is a multiple spindle drill-press, with a very coarse feed $\frac{1}{4}$ to $\frac{3}{8}$ in. to a revolution. Below each spindle is what may be called a die or a cast-iron block with a hole somewhat larger than the bolt. Located radially around this hole are four cutters or tools for the rough cut on the bolt. These tools have a long cutting face and are accurately ground for the purpose. The block and cutters are submerged in oil. The block or die for the finishing cut has only two cutters opposite each other, and between them are two V-shaped guides for steadying the bolt as it is being finished. This method of turning bolts promises to work a revolution in doing this kind of work. It is said that a boy will turn as many as 1,000 $\frac{7}{8}$-in. bolts on one of these machines in a day. The work is better done than it would be on a lathe, and the taper and size of each bolt must be correct if the tools are properly maintained.

An interesting feature in connection with the Baldwin Locomotive Works is the restaurant, or rather what might be called the club rooms, which have been established in their works for the use of their workmen. To describe this we will be obliged to go back somewhat and say that, in Philadelphia, they have what they call the "Neighborhood Guild Association," the object and purpose of which is described as follows in one of the publications of the Guild:

The "Neighborhood Guild Association" was organized in December, 1887, by a number of citizens representing various religious denominations, professions, and callings, for the purpose of providing in different localities of the city better social and educational opportunities for the people of the neighborhood, including young and old of both sexes. Our organization and work are absolutely unsectarian. Any person by the payment of an annual fee of $5 may become a member of the Association and vote at the annual meeting. An executive committee of 12 persons is annually elected. Members of the Association are entitled to all the privileges of the Neighborhood Guild rooms.

The practical work of the Neighborhood Guild Association began at Pequa Hall, Twenty-third and Hamilton streets, early in 1888, with a series of Saturday evening entertainments, consisting of concerts, dramatic performances, lectures, etc. A house was soon rented at 2134 Vine Street, and a coffee-room, reading-room, and library were established; rooms were furnished for games, music, classes, etc.; and the basement was fitted up for manual training. During the first and second seasons classes were started in carpentering, wood-carving, drawing, clay-modeling, dress-making, cooking, and vocal music. Early in the present season classes were formed in political economy, history, literature, short-hand and vocal music; and courses of lectures on hygiene, economics, and popular scientific subjects were arranged. By the first of the present year it was found necessary to look for a house with larger accommodations.

The proprietors of the Baldwin Locomotive Works, hearing of this, and wishing to provide a restaurant where their men could obtain a good dinner at a reasonable price, made the following offer to the Neighborhood Guild Association:

"If," they said, "you will undertake the entire management of a restaurant that we propose to equip, running it without profit and using all gains to reduce prices and improve quality, we will compensate you by giving you, rent free, the use of the rooms over the restaurant, and furnishing electric light and steam-heat without charge."

This offer was promptly accepted, and on February 1 the Guild moved to its present commodious and pleasant quarters, southwest corner of Fifteenth and Spring Garden streets. On the second floor we have a large and well-appointed restaurant, at which good food at cost prices is furnished to the workingmen of the neighborhood. Over the restaurant we have an attractive and pleasant lecture-room, several class-rooms, and a reading-room. A room on the sixth floor, 30 × 120, recently placed at our disposal, is being fitted up as a gymnasium. Since coming into our new quarters the classes begun at the

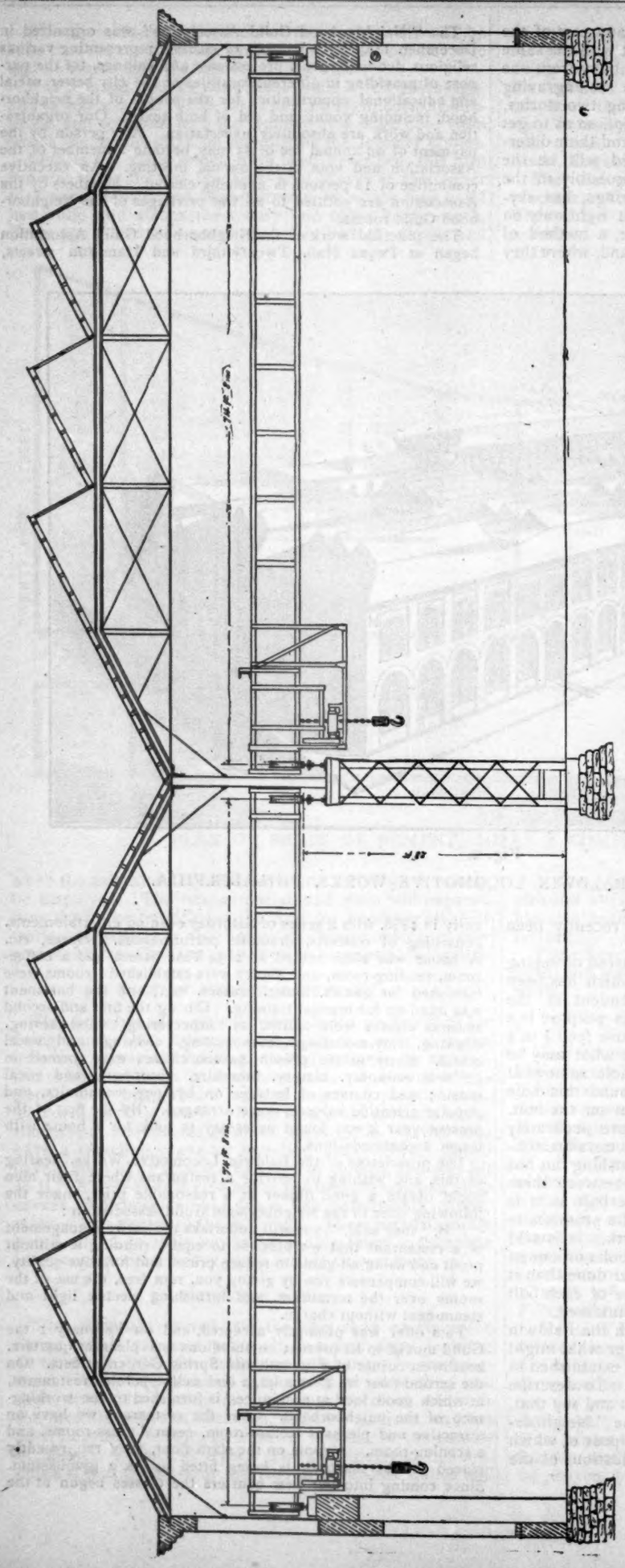


Fig. 3. CROSS-SECTION OF ERECTING SHOP, BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Vine Street house have been continued, and in addition classes in physiology, penmanship, elocution, instrumental music, gymnastics, and military drill have been formed, besides classes in kindergarten, kitchen-garden, etc., for the children in the afternoon.

The rooms in the Baldwin Works are light, cheerful, and scrupulously clean, and are well patronized both at meal times and in the evenings. The bill of fare for the day, posted on the blackboard, when we visited the dining-room, was soup, roast beef, veal pot-pie, two vegetables, bread and butter, tea, coffee, or milk, all of which was supplied for 15 cents. The extras were: pie, 5 cents; pudding, 3 cents; floating island, 3 cents; bread and butter and coffee, 5 cents; tea or coffee, 3 cents; crackers and milk, 3 cents. The quantity of these different articles furnished is very liberal; the glasses, for example, in which coffee and milk are served, are in the form of a frustrum of a cone $3\frac{5}{8}$ in. diameter at the top and $2\frac{1}{2}$ in. at the bottom and 5 in. deep. We leave the problem of calculating its contents to some of our young mathematical readers.

The rooms and restaurant are under the charge of a matron, Miss V. M. Walker. Altogether it seems to be an admirable method of benefiting workingmen, and of showing that those who employ them have a fellow-feeling for them, and it might be imitated to advantage in many other similar establishments.

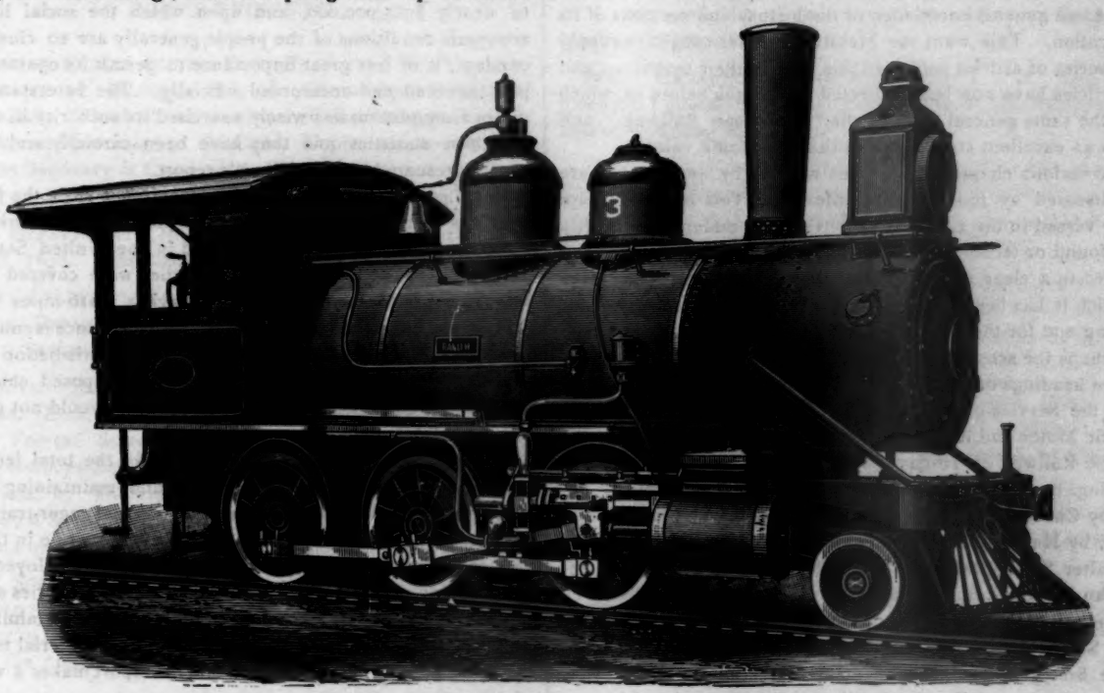
A locomotive-shop is not a place where one would expect to encounter romantic incidents, nevertheless it seems as though that phase of human experience follows mankind in all walks of life, and refuses to be eliminated from even the most prosaic occupations. The particular incident to which these remarks are introductory is the fact that the Baldwin Works have recently furnished some locomotives for the Jaffa & Jerusalem Railroad in Palestine. This is a meter-gauge road, which is being built from Jaffa—the ancient Joppa of the Bible—which is the port of Jerusalem. Fig. 4 is an engraving of one of the locomotives which has arrived in Jaffa, and has been put to work on the new Judean railroad. As the engraving shows, it is of the "mogul" type, which seems appropriate for a locomotive sent to the Orient. It has 15 × 18 in. cylinders, driving-wheels 41 in. diameter, and weighs 58,000 lbs. The Baldwin Works agent, who was sent over to put up the engine, has written the following interesting letter in relation thereto:

HOTEL JERUSALEM, JAFFA, October 3, 1890.

MESSRS. BURNHAM, PARRY, WILLIAMS & COMPANY:

GENTLEMEN: I am very glad to be able to report that we made a successful trial trip of the first engine (*Jaffa*) to-day. All Jaffa was out to see it, including the Turkish Governor and his court. It was estimated that at least 10,000 people were on the housetops and along the line of the road, and over two-thirds of them never saw a locomotive before. Many of the

Arab women moved their household effects along the line of the road several days ago, so as to be on hand when the great thing went along. Many flags were hoisted over public buildings in honor of the occasion. I got an American flag from the Consul and put it on the front bumper. The French engineer put two French flags on each corner of the cab, and we secured a Turkish one on the other corner of the bumper, and so we went up into the town. I doubt if any other engine built by the Works ever received so much attention as 8–24 D, and as for me, well, I never expected people to regard me as the Arabs did to-day and have been doing. They simply think that I have been cutting and carving it out of a lot of railroad iron and boxes. They have a great respect for the French engineers and think them very smart, but when it comes to making a machine such as they saw to-day, "they can't do it in France," "they had to send to America for a man to make it." The officers of the road were very much concerned about the engine getting through some of the sharp curves along the wall, and also the strength of the track; in fact, they offered to make any alteration I might want. I had examined the track carefully, and saw nothing that the engine was not able to take easily. Before starting they got some screw jacks, blocks, and other things, and were piling them up on the engine. I asked the superintendent what they were for, and he said to put her on the track if she got off. "All right," I said, "but we won't need them." We went over the short piece of road in good style and without a stop. She went fast enough also to keep the flags to the breeze, so that all would see what sort of flags they were. They were all very much pleased that no change had to be made, and that the engine curved so nicely. The machinery has all come right so far and without trouble. We expect to start on the second one to-morrow.



MOGUL LOCOMOTIVE FOR THE JAFFA & JERUSALEM RAILROAD.

BUILT BY THE BALDW N LOCOMOTIVE WORKS, PHILADELPHIA.

All the circumstances connected with the event of starting a locomotive in the land in which the principal events narrated in the Bible transpired recalls Hood's poem on

THE IMPUDENCE OF STEAM.

Over the billows and over the brine,
Over the water to Palestine!
Am I awake, or do I dream?
Over the Ocean to Syria by steam!
My say is sooth, by this right hand;
A steamer brave
Is on the wave,
Bound, positively, for the Holy Land!

GODFREY of Bouillon, and thou,
RICHARD, lion-hearted King,
Candidly inform us, now,
Did you ever?
No you never
Could have fancied such a thing.
Never such vociferations
Entered your imaginations
As the ensuing—
"Ease her, stop her!"
"Any gentleman for Joppa?"
"'Mascus, 'Mascus?" "Ticket, please, sir."
"Tyre or Sidon?" "Stop her, ease her!"
"Jerusalem, 'lem! 'lem!"—"Shur! Shur!"
"Do you go on to Egypt, sir?"
"Captain, is this the land of Pharaoh?"
"Now look alive there! Who's for Cairo?"
"Back her!" "Stand clear, I say, old file!"
"What gent or lady's for the Nile,
Or Pyramids?" "Thebes! Thebes! sir!" "Steady!"
"Now, where's that party for Engedi?"

Pilgrims holy, Red Cross Knights,
Had you e'er the least idea,
Even in your wildest flights,
Of a steam trip to Judea?
What next marvel Time will show,
It is difficult to say,
"Buss," perchance, to Jericho;
"Only sixpence all the way."
Cabs in Solyma may ply;—
—'Tis a not unlikely tale—
And from Dan the tourist hie
Unto Beersheba by "rail."

The author of the letter from which we have quoted also sent several photographs showing views of part of Jaffa, with the narrow-gauge road along the edge of the waters of the Mediterranean, and the locomotive in the distance. From these photographs a person can select for himself which of the houses shown was the residence of "one Simon, a tanner whose house was by the seaside," and also the housetop on which Peter "fell into a trance." Without any irreverent intention, we may wonder what changes would have been made in Chapter X. of the Acts of the Apostles if the little narrow-gauge

locomotive could have been seen by Peter, together with "the four-footed beasts of the earth, and wild beasts, and creepings things and fowls of the air," which then appeared to him. The Good Book says he "doubted in himself"—would his doubts have been increased or diminished by seeing the chariot of fire which has worked such wonders in modern life, and probably will be, literally, the forerunner of great changes in the Holy Land?

ELECTRICITY IN DAILY LIFE.

Electricity in Daily Life: a Popular Account of the Applications of Electricity to Every-day Uses, by various Authors. New York; Charles Scribner's Sons. 288 pages, 125 illustrations; price, $3.00.

During the past ten years electricity has been put to so many practical uses, and has come to play so large a part in our every-day household and business life, that every educated man and woman, without being an expert, will naturally wish to have some general knowledge of the history and methods of its application. This want the Messrs. Scribner sought to supply by a series of articles published this year in their magazine, and the articles have now been collected in the book before us, which is in the same general style as the "American Railway," and forms an excellent companion to that handsome volume.

The various chapters have been written by experts, but are not obscured by too much technicality. Too few of us are really versed in the science of electricity to understand readily a profound or technical work on the subject; but we are all interested in a clear explanation of its workings and of the ways in which it has been applied for the transmission of power, for lighting and for the other purposes which it now daily serves.

Perhaps the scope of the book can best be explained by giving the headings of its chapters, which are as follows: Electricity in the Service of Man, by Professor C. F. Brackett; the Electric Motor and its Applications, by Franklin L. Pope; the Electric Railway of To-day, by Joseph Wetzler; Electricity in Lighting, by Professor Henry Morton; the Telegraph of To-day, by Charles L. Buckingham; the Making and Laying of a Cable, by Herbert Laws Webb; Electricity in Naval Warfare by Walter S. Hughes, U. S. N.; Electricity in Land Warfare, by John Millis, U. S. A.; Electricity in the Household, by A. E. Kennelly; Electricity in Relation to the Human Body, by M. Allen Starr, M.D.

The first chapter is a general introduction to the subject, which the others follow in detail, showing how electricity has been applied in manufacturing, in transportation, in lighting, in transmitting messages, in lightening household work, in medicine, and how it is proposed to use it in warfare, for so far, fortunately, there has been but little chance for its use in actual war. The telegraph is the oldest of these practical applications and the one with which we are most familiar, but even with respect to that and its later adjunct, the telephone, popular knowledge is still somewhat vague, and almost every one will read the chapter on that subject with interest. The various forms and applications of the electric motor are daily becoming more familiar, and the electric railroad is steadily making its way in our cities and towns, so that the electric car is no longer a curiosity, but a part of daily life and experience in so many places, that an explanation of the principles on which it is based cannot fail to command the attention of numerous readers. The same thing can be said of the electric light, but the application to the smaller household uses is still comparatively new, and should be carefully studied. The chapter on applications in medicine seeks to confute some false ideas which are current and to show the real and valuable uses to which electricity may be put in this direction, and to expose some quackery, the partial success of which has been based on popular ignorance.

The book is not a profound scientific treatise for the electrical engineer, but as a popular work it gives general views of the subject based upon sound scientific knowledge, and it is well worth attention, not only from the general reader, but also from the engineer, who, while not making electricity his specialty, wishes to know what has been done and upon what the advances made in that department have been based.

NEW PUBLICATIONS.

SECOND ANNUAL REPORT ON THE STATISTICS OF RAILROADS IN THE UNITED STATES TO THE INTERSTATE COMMERCE COMMISSION, FOR THE YEAR ENDING JUNE 30, 1889: HENRY C. ADAMS, STATISTICIAN TO THE COMMISSION. Washington; Government Printing Office.

Reference has frequently been made in these columns to the importance of securing uniform and official reports of the condition and operations of the railroads of the United States. An interest in which the investment is represented by $8,600,000,000 of securities, the yearly gross revenue of which amounts to nearly $965,000,000, and upon which the social life and economic conditions of the people generally are so closely dependent, is of too great importance to permit its operations to pass unnoted and unrecorded officially. The Interstate Commerce Commission has wisely exercised its authority in collecting these statistics, and they have been carefully and intelligently presented in Mr. Adams's report.

In collection much progress has been made since the first report was issued. According to the figures of the Commission there were 157,759 miles of railroad in the United States on June 30, 1889, and of this 149,949 miles were covered by the reports made to the Commission, leaving 7,810 miles not reported on. As nearly every line of any importance is concerned in interstate business and comes under the jurisdiction of the Commission, the unreported mileage is composed chiefly of short and unimportant lines, whose addition would not greatly affect the totals and averages obtained.

The mileage given above is of railroad; the total length of track was 200,950 miles, in operating and maintaining which there were used 29,036 locomotives, 25,665 passenger-train cars, 1,040,269 freight cars, and 31,657 service cars; while in the service of the roads 704,743 persons were directly employed. To these should properly be added those at work in factories supplying railroad material, but there is no way of ascertaining the number of that class. With the amount of material to work upon, it is not to be wondered at that the report makes a volume of 566 pages.

The Statistician recognizes fully the importance and the difficulties of the work imposed upon him. While admitting that the railroad companies in most cases have readily complied with requirements, and have co-operated with him in furnishing the reports required, and that substantial progress has been made toward securing full and uniform reports, he points out that there is still a class of corporations which have a considerable part in railroad business, but of whose work it is difficult to get exact figures. These are the fast freight lines, terminal companies, car companies and other subsidiary corporations, whose operations directly concern the railroad companies, but whose accounts are separately kept, and whose income and expenses do not appear directly in the railroad reports. The task Mr. Adams has undertaken of bringing these into the statements is not an easy one, but it is hoped that his efforts will meet with full success. The use made of such subsidiary corporations forms an interesting chapter in the history of some companies—but a chapter not often published.

The Statistician has his work now well in hand, and the third report may be expected to show a still further improvement. It might be suggested that if it could be brought out in somewhat less than a year after the end of the year covered, its value to the student and the railroad man would be increased considerably.

REPORT OF PROCEEDINGS OF THE TWENTY-FOURTH ANNUAL CONVENTION OF THE MASTER CAR-BUILDERS' ASSOCIATION, HELD AT OLD POINT COMFORT, VA., JUNE 10, 11, AND 12, 1890. Chicago; published by the Association, John W. Cloud, Secretary.

The present report makes a volume of 210 pages, with 15 large plates, some 50 pages being taken up by the description of the standards, constitution of the Association, etc. The proceedings include some reports and discussions of interest, including that of the Committee on Steel Plate and Malleable Iron in Car Construction, a subject of considerable importance.

The Rules for Repair of Cars Interchanged for Traffic, with the debate upon the amendments, occupy a considerable part of the report, as they did of the time of the Convention. This is an important part of the work of the Association, and the discussion on the rules often brings out some notes of experience which are worth preserving.

BOOKS RECEIVED.

SELECTED PAPERS OF THE CIVIL ENGINEERS' CLUB OF THE UNIVERSITY OF ILLINOIS, 1889–90. Champaign, Ill.; issued by the Club. This includes a number of interesting papers prepared for and presented to the Club. Copies can be obtained from the Secretary at Champaign, Ill.; price 30 cents each.

REPORTS OF THE CONSULS OF THE UNITED STATES TO THE STATE DEPARTMENT: No. 119, AUGUST, 1890: No. 120, SEPTEMBER, 1890. Washington; Government Printing Office.

FRUIT CULTURE IN FOREIGN COUNTRIES: SPECIAL REPORTS TO THE DEPARTMENT OF STATE FROM CONSULS OF THE UNITED STATES. Washington; Government Printing Office.

SELECTED PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution, James Forrest, Secretary. The present installment of these papers includes the Effect of Chilling on the Impact Resistance of Metals, by Thomas Andrews; Calorimeters for Testing Fuels on a Small Scale, by Bryan Donkin and John Holliday; Abstract of Papers in Foreign Transactions and Periodicals.

OUR SCHOOLS; WITH PARTICULAR REFERENCE TO TRADES SCHOOLS: BY JOSEPH M. WILSON, C.E., PRESIDENT OF THE FRANKLIN INSTITUTE. Philadelphia; reprinted from the *Journal* of the Franklin Institute.

TWENTY-FIRST ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF MASSACHUSETTS: HENRY P. WALCOTT, M.D., CHAIRMAN; SAMUEL W. ABBOTT, M.D., SECRETARY; FREDERIC P. STEARNS, CHIEF ENGINEER. Boston, Mass.; State Printers.

INDEX TO THE REPORTS OF THE COMMITTEE ON SCIENCE AND THE ARTS OF THE FRANKLIN INSTITUTE, 1834–90: COMPILED UNDER DIRECTION OF THE COMMITTEE BY PERCY A. BIVINS. Philadelphia; published by authority of the Institute.

FLOW OF WATER IN OPEN CHANNELS, WITH TABLES BASED ON KUTTER'S FORMULA: BY P. J. FLYNN, C.E. San Francisco; reprinted for the Author from the *Transactions* of the Technical Society of the Pacific Coast.

REPORTS ON THE PROJECTED WORKS OF THE TULARE IRRIGATION DISTRICT, TULARE COUNTY, CALIFORNIA: P. J. FLYNN, CHIEF ENGINEER. Tulare, Cal.; issued by the Board of Directors.

THE COMPOUNDING OF LOCOMOTIVES BURNING PETROLEUM REFUSE IN RUSSIA: BY THOMAS URQUHART, LOCOMOTIVE SUPERINTENDENT GRASI-TSARITSIN RAILROAD. This is a paper read by Mr. Urquhart before the Institution of Mechanical Engineers in London; it is illustrated by a number of drawings, and is supplemented by a report of the discussion on the paper.

R. UNIVERSITA ROMANA: SCUOLA D'APPLICAZIONE PER GL' INGEGNERI: PROGRAMMI D'INSEGNAMENTO E ANNUARIO PER L'ANNO SCOLASTICO 1890–91. Rome, Italy; published for the University.

REPORT OF THE MASSACHUSETTS BOARD OF RAILROAD COMMISSIONERS IN RELATION TO THE ACCIDENT ON THE OLD COLONY RAILROAD NEAR THE QUINCY STATION, AUGUST 10, 1890. Boston, Mass.; State Printers.

PERMANENT FORTIFICATION FOR ENGLISH ENGINEERS: BY MAJOR J. F. LEWIS, R.E. Chatham, England; published by the Royal Engineers' Institute.

FIFTH ANNUAL REPORT OF THE COMMISSIONER OF LABOR; 1889. RAILROAD LABOR: CARROLL D. WRIGHT, COMMISSIONER. Washington; Government Printing Office.

GENERAL SOLUTION OF THE TRANSMISSION OF FORCE IN A STEAM ENGINE, AS INFLUENCED BY THE ACTION OF FRICTION, ACCELERATION AND GRAVITY: BY D. S. JACOBUS. Hoboken, N. J.; reprinted from *Transactions* of the American Society of Mechanical Engineers.

SOME ONTARIO MAGNETITES: BY T. D. LEDYARD. Toronto, Canada; from the *Transactions* of the American Institute of Mining Engineers.

THE WATER POWER OF THE FALLS OF NIAGARA APPLIED TO MANUFACTURING PURPOSES: THE HYDRAULIC TUNNEL OF THE NIAGARA FALLS POWER COMPANY. Niagara Falls, N. Y.; published by the Business Men's Association.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, No. XX., SEPTEMBER, 1890. Ithaca, N. Y.; published by the University.

THE EDGAR THOMSON STEEL WORKS AND BLAST FURNACES: CARNEGIE BROTHERS & COMPANY, LIMITED: ILLUSTRATED DESCRIPTION. Pittsburgh, Pa.; issued by the Company.

THE FRICK COMPANY, ENGINEERS: ILLUSTRATED CATALOGUE AND DESCRIPTION OF "ECLIPSE REFRIGERATING MACHINES." Waynesboro, Pa.; issued by the Frick Company.

EXHIBITION OF PICTURES BY MODERN MECHANICAL PHOTOGRAPHIC PROCESSES: NOVEMBER 3–15, 1890. New York; the New York Camera Club.

ABOUT BOOKS AND PERIODICALS.

IN BELFORD'S MAGAZINE for November Captain W. H. Parker concludes his article on the Early Discoveries of America. The other articles include an excellent variety of substantial and lighter matter.

An article which engineers will read with interest is Robert Brewster Stanton's Through the Grand Cañon of the Colorado, in SCRIBNER'S MAGAZINE for November. It describes the trip of a railroad surveying party down the Colorado from Grand Forks to the Gulf of California—the second trip ever made through the Grand Cañon. In this number also Mr. Zogbaum's account of the cruise of the Squadron of Evolution, and Professor Shaler's Nature and Man in America are concluded.

In the December number of SCRIBNER'S is the first of a series of papers on Japan by Sir Edwin Arnold. During 1891 this magazine will contain other papers on Japan by the same author; Explorations in Northern Mexico, by Dr. Karl Lumholtz; several articles on Australia, including one on the railroads of that country and the results of Government ownership; The Great Streets of the World; a series of articles on Ocean Steamships, similar in treatment to the railroad articles pub-

lished some time ago; and also the usual variety of lighter matter.

The leading and longest paper in the last quarterly BULLETIN of the American Geographical Society is on Canada, the Land of Waterways, by Watson Griffin. Other papers are on Modern Iceland, by Professor Charles Sprague Smith, and on the Upper Amazon, by Courtenay De Kalb. The Geographical Notes, by Librarian Hurlbut, contain several points of interest.

The account of the National Guard of Minnesota is completed in OUTING for November. This may be called a traveler's number, for its articles include descriptions of outdoor life and sport in Long Island, in Florida, Wisconsin, California, Canada, and Norway.

In the POPULAR SCIENCE MONTHLY for November Professor Mendenhall writes of the Relations of Men of Science to the General Public. An article by George Iles gives some suggestions on teaching geometry which are worth studying.

Switzerland and Japan are the subjects of descriptive articles in HARPER'S MAGAZINE for November, while Mr. Child continues his South American articles, his subject this month being Urban and Commercial Chili. Southern California is written of also under the title of "Our Italy," the article being descriptive and a little prophetic as well.

Charles Scribner's Sons, New York, have in preparation two books which will be of much interest to engineers. The first is the LIFE OF JOHN ERICSSON, by Colonel Church, who was an intimate friend of the great engineer for many years, and has also had the use of his papers and correspondence in preparing this work. The second is ELECTRICITY IN DAILY LIFE, an account of the applications of electricity to practical use, prepared by several writers.

The November number of the ARENA completes the second volume of that magazine, which has now fully established its place in the reading world. The life of the ARENA is discussion, and in its columns all sorts of questions, including some of the gravest importance, have been discussed with a vigor and freedom which we find nowhere else. That this method finds approval with a large public is an excellent sign, and the new magazine deserves the best congratulations on its success.

The latest quarterly number of the JOURNAL of the New England Water Works Association is the report of the Ninth Annual Convention, which was held in Portland, Me. It includes several papers of value, with reports of the discussions on them.

In the JOURNAL of the Military Service Institution for November the leading article is on Our Northern Frontier, by Lieutenant A. D. Schenk, treating of the provisions which should be made for the protection of our national interests on the Great Lakes. Other articles are on the Light Battery in Peace; on the Practical Education of the Soldier, by Lieutenant C. D. Parkhurst, and on the Development of Naval Armor, by Lieutenant John Conklin, Jr. The translations include Russian Ideas on Fortification; the German Cavalry and a Continuation of Prince von Hohenlohe's letters on Artillery, with some shorter notes of much interest.

ANSWER TO A PROBLEM IN LAND SURVEYING.

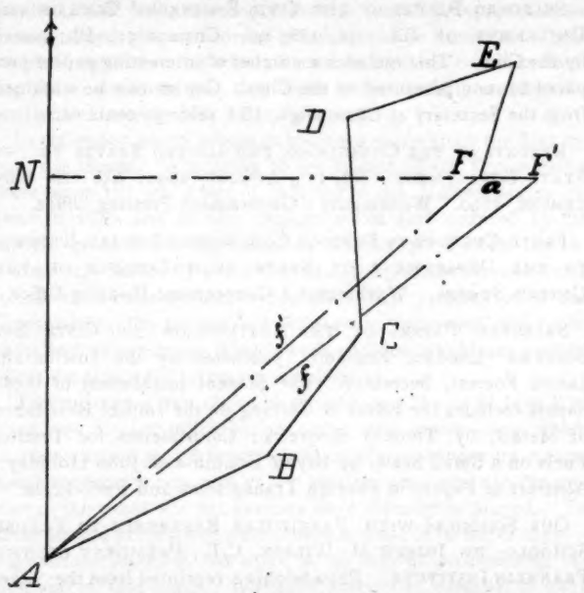
PROBLEM: *To correct a random traverse of several courses between two known points.*

This is a very common problem with which the land surveyor has to deal in the location of boundaries of irregular tracts of land, retracing old highway lines, and relocating meander lines. It seems to have escaped the attention of most authors as well as of surveyors, and it is believed that correct solutions of the problem, by surveyors in the field, are the exceptions rather than the rule.

To solve the problem we need a convenient basis of comparison between the courses and distances of the true line and those of the random. This will best be found by calculating the courses and distances of lines which will join the starting and closing points of the two surveys, calculating both as they would be according to the meridian and the measure of the random. It is better to calculate these in terms of the random, because of the greater convenience to the surveyor in applying his corrections in the field.

Preliminary Propositions.—1. A difference in length of the chains on different surveys by the same notes from a common starting-point, causes a difference in the length of the respective courses without changing their direction. Hence, the closing points of the several surveys will all lie in one straight line with the common starting-point, and the relative length of the several chains is shown by the distances of the closing points from the common starting-point.

2. The effect of using different meridians (or variation of the needle) in such a case is to swing the lines around the starting-point as a center without changing the lengths of the courses or their angles with each other. Hence if



chains are of equal length the termini of the surveys will all lie in one arc, having the common starting-point for its center.

3. Hence the position of the terminus of a random, with relation to such a line and arc, passing through the terminus of the true line determines both the difference in length of chains and of the meridians of the two surveys.

Let A, B, C, D, E, F represent a true line of several courses, and F the terminus of a random run from A to retrace the line, the course and distance of the line FF' being known.

From A draw AF and AF'.

The angle FAF' measures the difference in courses, or, in other words, the correction for variation of the needle.

The length of the lines AF and AF' measures the comparative length of the chains used on the two surveys. $\frac{AF}{AF'}$ is the length of the chain used on the true line in terms of the chain used on the random.

The course of any part of the broken line, as AB (in terms of the random), is equal to the bearing, by the original notes $\mp$ the angle FAF'.

The length of any course, as AB in terms of the random, is equal to the length given in the original notes $\times \frac{AF}{AF'}$.

To find the correction to be applied to the stakes in the angles of the random, first compute the total latitude and departure of each of the points in the random line.

Second, convert the notes of the true line into terms of the random by changing the bearings and lengths of the several courses, and giving them as they would be according to the meridian and chain of the random, and compute the total latitudes and departures of the several points.

A comparison of the two results will give the correction to be applied at each stake of the random.

Example.—A highway between nearest known points is described as follows:

1st. N. 62° E., 14.00 chains.
2d. N. 43½° E., 8.00 "
3d. N. 5° W., 12.00 "
4th. N. 72½° E., 10.25 "
5th. S. 12° W., 6.43 "

A random run with variation of needle 2° 17′ E. came out 62 links east of the point. Stakes were set at the angles of the random.

1. What is the variation of the needle as referred to the meridian of the original survey of the highway?

2. How much, and in what direction, must the stakes in the angles of the random be moved, to place them in the angles of the original line?

	N.	S.	E.	W.	Total Lat.	Total Dep.
1. N. 62° E., 14.00	6.57	....	12.36	....	6.57	12.36
2. N. 43½° E., 8.00	5.80	..	5.51	....	12.37	17.87
3 N. 5° W., 12.00	11.95	....	....	1.05	24.32	16.82
4. N. 72½° E., 10.25	3.08	....	9.78	....	27.40	26.60
5. S. 12° W., 6.43	....	6.29	....	1.34	21.11	25.26

$\text{Tan. } F'AN = \frac{NF'}{AN} = \frac{25.26}{21.11} = 1.19663 = \text{tan. } 50° 7'. \therefore AF'F = 39° 53'.$

$AF = \sqrt{AN^2 + NF^2} = \sqrt{21.11^2 + 25.26^2} = 32.92.\ FF' = .62.$

In the triangle AFF' we now have two sides and the included angle to find the remaining parts. We will call the angles AF and F' and the sides opposite af and f'.

$$f + a : f - a :: \text{tan. } \frac{F + A}{2} : \text{tan. } \frac{F - A}{2}.$$

$$32.92 + 62 : 32.92 - 62 :: \text{tan. } \frac{140° 07'}{2} : x;$$

or $33.54 : 32.60 :: 2.75621 : 2.65431$, whence $x = \text{tan. } 69°21\frac{1}{2}'$.

$$A = 70°.03\frac{1}{2}' - 69°.21\frac{1}{2}' = 42'.$$

As the random came out east of the true line, the correction 42′ must be added to the assumed 2° 17′ to find the variation of the needle from the meridian of the original survey = 2° 59′ E. This will only need to be used in case the line is to be run over again.

To find f'.— Sin. A : Sin. F' :: 62 : f'.
.01222 : .64123 :: 62 : 32.446.

The length of the original chain in terms of the chain used in the random = $\frac{f}{f'} = \frac{32.446}{32.92} = .9856$.

We will now apply these corrections to the original notes, reducing them to the meridian and measure of the random, and again compute total latitudes and departures.

	N.	S.	E.	W.	Total Lat.	Total Dep.
1. N. 61° 18′ E., 13.80	6.63	....	12.10	....	6.63	12.10
2. N. 42° 48′ E., 7.88	5.78	....	5.35	....	12.41	17.45
3. N. 5° 42′ W., 11.83	11.77	...	...	1.17	24.18	16.28
4. N. 71° 48′ E., 10.10	3.15	....	9.60	....	27.33	25.88
5. S. 11° 18′ W., 6.34	....	6.22	....	1.24	21.11	24.64

The last course is computed simply as a check to prove the correctness of the work, which it does. We now compare results to find the corrections to be applied to the stakes in the random to place them in the true line.

	B.		C.		D.		E.		F.	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
Random line.	6.57	12.36	12.37	17.87	24.32	16.82	27.40	26.60	21.11	25.56
True line.....	6.63	12.10	12.41	17.45	24.18	16.28	27.33	25.88	21.11	24.64

Stakes are to be moved as follows: At B, North, .06; West, .26; at C, North, .04; West, .42; at D, South, .14; West, .54; at E, South, .07; West, .72—at F, West, .62.

If it is desirable to correct the stakes by measuring a single course and distance, we may solve these small right triangles.

Taking the first one at B, $\sqrt{6^2 + 26^2} = 26.7$. $\frac{26}{6} = 4.333 +$ = tan. 77°; hence the correction is N. 77°, W. 26.7 links. At C it is N. 84° 34′, W. 45½ links. At D, S. 75° 28′, W. 55.6 links. At E, S. 84° 27′, W. 73. 3 links.

[NOTE.—This problem, submitted by Mr. F. Hodgman, C.E., of Climax, Mich., was published in the JOURNAL for September, page 417. Several answers have been received, but none were correct, and Mr. Hodgman therefore furnishes the above solution.]

AIR-BRAKE FAILURES.

IN a letter to the New York *Tribune*, Mr. P. H. Griffin, President of the New York Car-Wheel Works, makes some excellent observations on this point. After explaining the connections between the brake cylinders and the brake-shoes, which are familiar to most of our readers, he says:

When the connections are adjusted with new brake-shoes and everything in proper order, a piston travel of 4 in. will apply the brakes. As the shoes wear out or the connections give under strain or wear at the pivotal points, the piston travel must necessarily increase to effectively apply the brakes. The wear of brake-shoes is rapid, and the total effective travel of the piston is more than exhausted in the wearing out of one brake-shoe. Constant attention must therefore be given to the connections to see that they are of proper length, and inspectors at certain points have this work in charge. As a rule the work cannot be done until trains are all made up and ready for departure; the air pressure is then applied, the travel of the piston watched, and if it is too great the connecting-rods should be shortened in order that the brakes may be applied with less piston travel and a margin of safety provided to allow for wear. The very short time available for this work, the hurry and confusion incident to the departure of trains and the pressure to gain every moment of time in this age of minutes and seconds, are serious obstacles to a proper performance of the work; unfortunately, it cannot be done at any other time unless every car is taken to some point provided with apparatus for making a test, a practice almost impossible when the great number of cars in service is considered, as well as the one that drawing-room and sleeping cars are often in service constantly for months at a time. Even when the test is made, it is almost invariably the case that not over 40 to 50 lbs. pressure is used, with the result that sufficient strain is not brought upon the connecting-rods to apply the brakes with any pressure adequate for service, and the connections are pronounced all right by inspectors, when if a pressure of 70 lbs. were used, they would be found unfit for service.

The reports of the Michigan Central Railroad show that 2,316 cars passed Windsor, Ont., in the year 1889 with the pistons of air-brake cylinders travelling 12 in.; on such cars absolutely no braking power was obtainable.

Nearly all of these were sleeping cars running through from distant points, the inspection and care of brake attachments being given by different railroad companies. In transferring the cars across the river from Detroit to Windsor, and *vice versa*, time was afforded for testing the piston travel and a record taken with the above result. I do not know of any other railroad company making a systematic record of the kind. During the last year the Michigan Central have equipped their cars with indicators, operating automatically, that show the exact condition of piston travel at all times. When the indicator is used the maximum travel of the piston is always shown, and the necessary alteration to take up wear can be made at any time. From a careful investigation of the subject on many of the leading railroads of the United States and Canada, I have no hesitation in saying that on one quarter of all

cars in service the braking power is so small as to be absolutely useless in case it is necessary to make a sudden stop, for the causes given above. In every-day practice it can readily be seen that in making the usual stops an engineer can handle his train without difficulty; he knows perfectly the control he has over it, whether a moderate pressure will suffice, or whether extra pressure must be used. The latter is always dangerous, through liability to stop and slide wheels with entire loss of control. But when danger confronts him and he must strain everything for an immediate and unexpected stop—well, we know they are not always made, and that the difference of a few hundred feet has a terrible result. Investigation follows; it is said that "the air-brakes failed to work," and that is the end of it. I firmly believe if the attachments through which the air-brake does its work were always in proper condition accidents from this cause would be very rare.

The conditions of service above explained are in no way attributable to any feature of air-brake construction or application. The manufacturers of air-brakes have been indefatigable in their efforts to improve and perfect their devices. Without their labors it would be absolutely impossible to run trains at the speeds in practice to-day. It is only just to them, therefore, that accidents so commonly attributed to the failure of the air-brakes should be located where they belong, and that every effort be made on the part of railroad managers to supplement the valuable appliances now obtainable with every safeguard that can be found for their effective use.

FRICTION AND LUBRICATION OF JOURNALS.

(From the *Practical Engineer*.)

THERE is before us an interesting and valuable paper by Professor John Goodman, read before the Manchester Association of Engineers, giving the results of his own laborious investigations, as well as summarizing the work of others, and suggesting forms of bearings for journals more in accordance with the production of a minimum amount of friction than present practice.

Among many interesting facts, Mr. Goodman points out that the friction per square inch of a journal thoroughly lubricated, and so running upon an oil film, is, within limits, independent of the load. The limit is imposed by the pressure which the oil film will bear without being squeezed out and allowing the metals to come into actual contact with each other. At low speeds, however, the friction is greater than at high speeds, and it has been found to decrease gradually till a surface speed of 1,000 ft. per minute is attained, when it varies very slightly, being in fact practically constant for a considerable range. This is true, however, only for considerable loads per square inch, such as 400 lbs., the area of the journal being estimated by multiplying diameter of shaft by length of bearing.

At loads under 60 lbs. per square inch, according to Goodman, the friction gradually *decreases* with a reduction of speed, but when the intensity of the load is greater than this the friction increases when the speed falls below 50 ft. per minute. With low speeds a load greater than 60 lbs. per square inch seems to squeeze out the lubricant, and so increase the friction. The experiments elicited one interesting fact well known in practice to railroad engineers, namely, the effect of slight side-play in reducing the friction of a journal. A journal with a slight side-play, and moving from side to side, has greatly less friction than one in which the side-play is entirely taken up. It is, of course, impossible to allow any great amount of side-play to the crank-shaft of a steam engine, but still this fact proves how advisable it is to fit main brasses and connecting-rod brasses slightly easy, and explains the heating which is often caused by too good a job being made of the side fit.

A constant load must be less in intensity than an intermittent one; thus a dead load, such as is usually allowed on railroad axles, should not exceed 450 lbs. to 500 lbs. per square inch, while in crank-pins, where the load is intermittent, a maximum of 2,000 lbs. per square inch is often applied without heating. On the gudgeon ends, where the sliding velocity of the surfaces is not high, as much as 5,000 lbs. per square inch is allowed. The load, however heavy, takes some time to squeeze out the oil film, and so a heavy load only momentarily applied and then reversed does not get time to bring the metals into actual contact, although a smaller load continuously applied is quite able to do so. The whole efficiency of the journal depends upon its support upon this lubricating film, and the friction is caused, not by the contact of the metal surfaces, but by the continuous work of shearing the oil film existing between those surfaces. According to Goodman's experiments, this oil film measures from 0.0001 to 0.0004 in. thick. It is very interesting to reflect that the efficient working of our great engines depends on a lubricating film of from one ten-thousandth to four ten-thousandths of an inch thick, and furnishes one more illustration of the minute matters to be examined into before we can be said to understand the simplest actions of those great machines.

It is very customary in engines to oil the bearings from a hole in the upper brass by a syphon lubricator passing oil into grooves, but this, it appears, is bad practice, as the rotation of a journal causes a species of pumping action, which tends to force oil out at that very point. In some experiments it appears that when oil was supplied to the bearing from below, a continual stream of oil was forced up through the oil hole from the grooves, and on stopping up the hole the friction of the bearing at once diminished as much as 25 per cent. When the hole was opened it at once rose again. We may mention that in this case the load on the bearing came upon the upper brass in the same manner as if the upper brass were pressed down by a weight. The closing of the hole caused an oil cushion to be formed under the brass, and so diminished friction. Professor Goodman therefore recommends that oil grooves should not be placed along the line upon which pressure comes. When the pressure comes upon the lower brass, an oil groove in the upper brass is in the proper position, but when the pressure comes on the upper brass this is a bad arrangement.

When the pressure is vertical, as in a horizontal mill-shaft, the friction is greatly reduced by cutting away the sides of the brass, and the brass in contact gives the best results for minimum wear and friction when the brass width is seven-tenths of the diameter of the journal.

The Author recommends that brasses should never subtend an angle greater than 90°, the sides being cut away and pads inserted. Pad lubrication is confidently recommended as giving the minimum of friction and oil consumption as well. It consists in applying a woolen or felt pad kept soaked with oil and lightly pressed against the bearing, the supply of oil being kept up by means of lamp cotton, which soaks it up from a reservoir below.

As illustrating the efficiency of this method of working, we give the following case: A new pad weighing 14 drachms was supplied with 2¼ oz. of rape oil, and placed in contact with a 7-in. journal; total load on the brass, 4,984 lbs., or 237 lbs. per square inch. At the end of 319,660 revolutions, which is equivalent to 1,239 train-miles, the oily pad was weighed and found to be 2 oz. 2 dr.; hence only 1 oz. of oil had been used. The revolutions per minute were 166; the mean temperature of the journal was 130° Fahr., which rose to 145° at the end of the experiment; the mean coefficient of friction was 0.010, which rose to 0.012 at the end of the experiment. This is stated as the best result the author has obtained, but in many similar experiments the equivalent distance was over 1,000 miles.

In conclusion, the results of Professor Goodman's experiments seem to point to clearing away brasses, except at surfaces in line of pressure, limiting angular arc to 90° and introducing oil at the gaps by pads. A gas engine, whose bearings had been altered in the manner indicated, recently gave a mechanical efficiency of 90 per cent., which is very remarkable for a gas engine which has only one impulse for two revolutions.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

XIII.—THE DRYING OF PAINT.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

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(*Continued from page* 455.)

With the possible exception of durability, no quality of paint is more important to the consumer than its drying properties. Where there is an enormous amount of painting to be done, so that the painters can be kept constantly at work, and where there is an unlimited amount of room for the storing of the articles to be painted, it is, of course, no serious matter if the paint is two, three, or even four days in drying; but these circumstances, so far as our observation goes, almost never occur together. On railroads there is usually an enormous amount of painting to be done, but the track room, on which to store cars while they are drying, is usually quite limited in extent, and still another element of great weight comes in—namely, the loss of the use of the equipment while the paint is drying, provided it dries slowly. A single illustration will perhaps make this point clear. It is not at all rare that a railroad company has facilities sufficient for the manufacture of anywhere from 10 to 25 or 30 freight cars per day at one shop. Taking 20 as an average case, it is readily seen that if four days are required for each coat of paint to dry, track room enough must be provided to store 160 cars, since it is customary to give each freight car two coats of paint, and if the second coat cannot be put on until the fifth day, 80 cars would be first coated before a beginning could be made in second coating, and none of these on the supposition could be turned out until four days longer. We query whether there is a great manufacturing establishment or a railroad company in the United States which could without serious inconvenience furnish track room for 160 cars while they are being painted. Still further, as will be noted, after the car is finished in every respect except painting, on the supposition made above, it is six or eight days before it can go into service. This loss of service is no small matter, and as orders are usually not placed with the shops for cars until they are needed, and generally badly needed, the necessity that the paint should dry rapidly is certainly a matter of no small moment. We have, of course, taken an extreme view of the subject, as it is very rare, or perhaps almost never, that paint is used of such a kind that it takes four days for drying. The present practice, so far as our knowledge goes, usually turns a car into service the third morning after the painting is started, but even this causes such difficulties in the large shops that constant efforts are being directed toward the securing of paint which will dry more rapidly. Indeed, if our experience is of any value, almost every point, even durability, is in many cases sacrificed to rapid drying. Still further, so great is the necessity for securing rapid drying, that some large corporations are spending a great deal of money in providing facilities and special appliances in the way of shops for securing proper conditions, simply as a means of hastening drying. In the new passenger-car paint-shop of the Pennsylvania Railroad Company, at Altoona, devices have been made use of and appliances furnished, which cost no small amount of money, with no other idea in mind than to secure more rapid drying. It is perhaps not too much to say that any modification or device by which the total time of painting freight cars would be shortened six hours, and the time of painting passenger cars shortened three or four days, would be heartily welcomed by railroad companies. Of course everything cannot be sacrificed to this point, but a good many concessions can be made.

The drying of paint, so far as our observations go, depends a good deal on what the material is that is used to hold the pigment to the surface. In some cases the drying of paint is almost entirely evaporation; in other cases it is a complicated chemical process, and in other cases it is both. We will see if we can do something toward making these points clear. First, where the material that is used to hold the pigment to the surface is largely or almost entirely linseed-oil, drying is in a very slight sense evaporation. The drying in this case is a chemical change in the oil, resulting in the formation of an entirely different chemical body. Linseed-oil before drying is, as is well known, an oily, greasy liquid. Dry linseed-oil has entirely lost its oily condition and pretty nearly lost its greasiness, and is in reality a leathery, elastic substance, having more or less transparency and considerable tenacity, a melting point somewhere above 200° F., very insoluble in most substances, and when properly protected with pigment in ordinary paint a very durable substance. Unfortunately it is not water repellent, at least during the first month or six weeks after it is applied. The name given by Mülder to the principal constituent of dried linseed-oil is "Linoxyn."

Pure linseed-oil when exposed to the air changes from the oily condition to the dry condition very slowly. In the experiments which we have made we have hardly ever succeeded in getting pure linseed-oil alone to dry in less than four days, even under favorable conditions. It does dry, however, and like a number of other oils generally known as "drying oils," it seems to have within itself the characteristic of starting the process which results in the dry material. Quite a little study has been put on the question of what changes take place in linseed-oil during drying. As said above, unquestionably the drying of linseed-oil is a chemical operation, and is not, as many seem to think, a case of evaporation. We have not been able ourselves to make many positive experiments on the chemistry of the process. Mülder has given more study to the subject than any other experimenter with whom we are conversant, and if we understand him rightly his experiments seem to indicate that during drying linseed-oil takes up oxygen from the atmosphere or other sources, and gives off carbonic acid, acetic acid and formic acid. These three products, if we read Mülder correctly, he demonstrated to be formed and given off from the oil during drying. There is also the strongest probability for believing that water vapor is one of the products of the drying of linseed-oil. The circumstances under which Mülder conducted his experiments, however, did not enable him absolutely to demonstrate this point, but the reactions which he figures out require that water vapor should be formed in the process. A number of interesting experiments confirmatory in one way or another of these views have been tried. For instance, it is demonstrated that if linseed-oil is deprived of oxygen, it does not dry for weeks. Thus, if the inside of a flask is coated with linseed-oil and then the flask closed, drying does not take place for months. If, on the other hand, the air is changed in the flask, drying takes place readily. Furthermore, it is well known that at low temperatures drying takes place very slowly, as is also the case in a damp atmosphere. All these things are readily explained, if we understand the matter rightly, on the supposition that oxygen is taken up by the oil during drying, and that certain volatile products are given off. If oxygen is not fur-

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

nished, of course the chemical changes cannot take place. If the oil is in a closed place, although oxygen may be present, the space may become so saturated with carbonic acid, water vapor, and other volatile products formed during drying, that no more can be taken up by the air, and consequently drying stops. Furthermore, it is a general rule that low temperatures do not facilitate chemical reactions, while high temperatures do facilitate them, and finally if the air is saturated or nearly saturated with moisture, the escape of the moisture from the oil during drying into the air is retarded, which accounts for the fact that in damp weather oil dries more slowly. It is interesting to note that Mülder's experiments seem to indicate that, although we are accustomed to say linseed-oil is dry in the course of from two to four days, yet actually the chemical action goes on more or less for several months. Indeed, at one place Mülder cities that, as the result of direct experiment, chemical action had not ceased at the end of four months. Also Mülder is inclined to the view, if we understand him rightly, that the direct action of the sunlight is a very important matter in the drying of linseed-oil. Our own experiments rather incline us to the view that, so far as external circumstances are concerned, about the best which can be done to facilitate the drying of paint is to furnish warm dry air to the surfaces. A change of air is very essential, and this alone facilitates drying very greatly. If in addition the air is dry and the temperature from 90° to 100°, or possibly 110° F., drying takes place very much more rapidly.

The fact noted above by Mülder, that chemical change goes on for a period of time, is to our minds a very interesting one, and possibly explains what has already been noticed in previous articles—namely, that freshly dried linseed-oil is for at least a month or two more or less water absorbent, while very old dried linseed-oil seems to have lost this property to a greater or less extent. It is quite probable that a condition is ultimately obtained by the dried linseed-oil, in which its water-absorbent power becomes very small, with consequent increase in durability. The practical point which we draw from this information is that the probabilities are it is extremely desirable to have the drying progress as far as possible before the work is turned out or exposed to the elements, and our belief is that if the drying takes place in warm, dry air for from 36 to 48 hours before the work is turned out, the paint will have very much greater durability.

If Mülder's experiments are correct, and we see no reason to doubt them, it is obvious that linseed-oil can hardly be said to be fully dry until all the chemical change has taken place, and this, depending on the surroundings, may take months. It is obvious, therefore, that the question of when oil or paint is dry is subject to a great deal of uncertainty, and it is essential, therefore, to define what is meant by "dry." Practical painters have a number of terms in use which express to their minds the condition of the work, as, for example, "dust dry," "surface dry," "tachy," "ready for second coating," etc. These terms are, of course, variable, and being largely a function of the painter, it is hardly possible to compare different lots of paints. The practice in no two shops, so far as we are conversant, is entirely similar, and what one calls "dry," another calls "dry enough for second coating," or is "slightly tachy," or uses some other expression to characterize. In view of this difficulty of having some method of measuring the relative dryness of different paints, early in our study of paints, we set ourselves at work to devise a test for drying, not so much a test for the dryness of paint as a test for the dryness of linseed-oil which contained no pigment. We followed several lines of experiment, and finally decided on the following as enabling us to measure the relative dryness of different samples of linseed-oil. Take the material under test, lay it flat, and put on one edge of the surface three or four fresh No. 2 shot; then raise the edge where the shot are until the surface is vertical. If the material is dry the shot run off freely without interfering with the surface; if the material is fresh or not dry, they will stick or run down slowly, carrying some of the material with them. In our practical experience we have found this test to be a fairly good one, and it certainly enables comparisons to be made between the relative drying power of various mixtures of oil and japan which are entirely satisfactory. We are well aware that it is characteristic of certain mixtures to dry on the surface and not dry underneath, and that the method given above would not detect a failure to dry underneath. We do not offer the method as one covering every phase of the problem, but only as a means of comparing the relative dryness. We have never used the test much on paints, but see no reason why it should not apply equally well to paints. Of course it is obvious that the test can be varied by varying the size of the shot. The finer the shot the dryer the plate would have to be in order to prevent sticking and failure to run down the side. It is quite possible that the test may be expanded by sufficient experimenting to cover various phases of painting; for example, certain size shot might be used to tell when a paint was ready for second coating, and a different size to tell when it was ready for striping or putting on gold leaf, etc. It is, of course, obvious that where the paint must be tested on the work the method described above is not applicable, since the surfaces cannot have their positions changed. It will suggest itself readily to any one that by supporting the shot against a vertical surface for a second or two without using pressure would probably answer the purpose, the same as applying the shot when the surface is horizontal. We are quite willing to allow that a perfectly satisfactory test for drying, which can be used everywhere and which will give the same results every time, is still a desideratum, and the above test is only offered as a partial solution of the problem.

The slowness of the drying of linseed-oil, above referred to, has led to a large amount of experimenting for methods which would hasten the process. As already explained, four days is altogether too long to allow for a single coat to dry, and accordingly "dryers," as they are called, are in almost all cases added to paint to facilitate drying. We are free to confess that the action of dryers is not clearly understood, by ourselves at least. The facts seem to be these: Certain salts when put into linseed-oil have the property of very greatly facilitating the chemical change which we call drying. These salts may be certain oxides combined with the fat acids of the oil, forming in reality what we call "soaps," or they may be definite salts added to the oil in solid form. The most common illustration of the former is the substance known as "japan." Japan in reality, as we understand it, is simply lead and manganese soaps dissolved in turpentine These soaps may be made by taking raw linseed-oil and heating it with proper amounts of lead and manganese oxides, until chemical combination takes place between the fat acids of the oil and the oxides. Gum shellac, which is largely a free acid if our experiments are correct, may be added also and heated with the oxides, in which case a soap is made consisting of a combination between the oxides and the shellac. Some manufacturers also add certain of the copal gums to their japans, and the whole is finally dissolved in turpentine. As an example of solid dryers we may mention borate of manganese and acetate of lead. It will be understood that the dryers mentioned do not profess to cover the ground of materials which may be used to start and facilitate the drying of linseed-oil, but only to give examples. We hope, later on, to devote a whole article to the question of japan, and will therefore content ourselves here with saying that in some way, which we do not fully understand, the presence of a small amount of japan, made as above described, or of some of the solid dryers, shortens the time of drying linseed-oil from four days down to, under favorable outside conditions, as short a time as eight to 12 hours. Perhaps the best practice in railroad painting may be stated to be that a fresh coat is added every day. This practically allows 24 hours for the previous coat to dry and harden.

It is an interesting question as to why the presence of small amounts of the soaps above described, or the solid dryers, should facilitate the chemical change which causes linseed-oil to dry. We are not aware of any investigation which has demonstrated exactly how the dryers act, or why they facilitate the drying. We do know that so small a percentage as about 2.00 per cent. of properly prepared lead and manganese soaps, added to linseed-oil, will cause a

sample of linseed-oil, spread in a thin layer on a glass plate, to be practically dry in from two to four hours, while the self-same linseed-oil spread in the same thickness of layer on a glass plate, and without the addition, will be from three to four days in becoming equally dry. We presume many practical painters will regard this statement as subject to some doubt, but we should be very glad to demonstrate the truth of it to any one who feels in doubt. As we will try to make clear when we come to the article on japan, the method of making the lead and manganese soaps, and the consequent resultant qualities which they have, are exceedingly important elements in the drying. Not every japan is a good one, and the difference in the drying power of various commercial japans of the market is very wide.

If now our analysis of what constitutes the drying of linseed-oil is correct, it would seem very clear that in order to secure rapid drying of pure linseed-oil, the following conditions are necessary: First, the presence of a proper amount of properly prepared dryer added either in the form of japan or in the form of some of the well-known solid dryers; and, second, the furnishing of such outside conditions as will facilitate the absorption of oxygen and the escape of the volatile products formed during the drying of the linseed-oil. Laying aside the action of light, as being not under control, except that the shop should be made as light as possible, this last requires at our hands three things: First, change of air both to facilitate the supply of oxygen and to carry off the volatile products formed during drying; second, dryness of the air, since both the chemistry involved in drying, as above explained, and also all our experience indicates that the power of the air to take up moisture facilitates the drying of oil; third, raising the temperature as high as the work will bear, since almost all chemical changes are facilitated by the action of heat. If outside air is made use of to surround the work during drying, and fresh air is constantly taken in, no special facilities will be required to dry the air before it goes to the work, since the raising of the temperature of fresh air increases its capacity for taking up moisture, sufficient to make the air comparatively dry as it comes to the work. If, on the other hand, the air in the shop, as is now the case in some of the best shops, is used over and over again by a system of fans and pipes, being warmed as it goes into the shop, it may be essential to use some artificial means of taking the moisture and other products formed during drying out of the air as it returns from the work. We are not aware that this has been carried out practically on a large scale, since the passage-ways through which the air comes back to the heater usually themselves serve as condensers, and retain the largest portion of the products given off by the work during drying. It is undoubted, we think, that special appliances made use of to remove from the air, which has once been in contact with the work, the products which it has taken up from the paint, would greatly facilitate the drying in such shops as are fitted with the circulating systems.

The various requirements mentioned above as essential to get rapid drying may perhaps all be summed up in the single sentence—namely, use a good dryer and furnish the work during drying with a constant change of warm or heated air.

Thus far we have considered drying as a chemical change, and have not regarded that the material holding the pigment to the surface has anything in it which is volatile, except the products which are formed as the result of the chemical change described. So pure a case of drying as this is very rare, however, as we will try to make clear a little later. But before doing this we will consider what may be called "drying by evaporation." It sometimes happens in painting, and especially in what is known as carriage painting, that the material which holds the pigment to the surface is very little of it oil. Japan is largely used as this material, and there may be cases in which japan alone is used as the material to hold the pigment to the surface. In this case the drying is very largely, we hardly like to say wholly, a simple question of evaporation. As already described, most of the japans of the market are simply lead and manganese soaps, made by combining the acids of linseed-oil with the oxides of these substances, or by combining shellac with the same oxides, and many times containing more or less copal gum, the whole being held in solution by spirits of turpentine. These would be regarded as legitimate japans. There are also large quantities of japans containing practically the same soaps, in which benzine enters as an important part of the solvent. Sometimes the lead and manganese soaps are dissolved in benzine; again a mixture of benzine and turpentine is used. Rosin is also a frequent constituent of many cheap japans. Whatever be the solvents, the lead and manganese soaps, with the gums and oil uncombined, if any are present after the solvent has evaporated, are the materials which hold the pigment to the surface. These soaps without solvent are, so far as our experience goes, plastic, pliable, tenacious, leathery substances, with very little or no disposition to stain, and more or less adherent to any surface which they may happen to have been applied to. We should hardly like to say that lead and manganese soaps, from which the solvent has been evaporated, undergo no chemical change before they are fully dry, but practically these lead and manganese soaps are dry to the touch as soon as the solvent is gone. If now a paint is made, using japan wholly as the liquid, it is very easy to see how drying becomes simply an evaporation of the solvent. In our experience and observation it is hardly good practice to use japan alone, and we presume few master painters would recommend to do fine carriage painting with nothing but japan to hold the pigment to the surface, the reason being that the general belief is that the more japan in a paint the less its durability. In painters' language, "japans burn up the paint." As we will explain somewhat later, our own ideas on the subject are that it is much more important who makes the japan and how it is made than that oil should be a constituent of the material which holds the pigment to the surface, as we have some quite remarkable experiments showing extraordinary durability, where japan was a very large constituent of the paint, the only precaution being that the japan was, as we say, properly made. We have, however, cited the case of using japan only to hold the pigment on the surface simply to illustrate what is meant by drying by evaporation, in the same manner that in the early part of this article we have described somewhat at length the drying of linseed-oil as an illustration of drying due to chemical change.

In actual practice at the present time, so far as our observation and experience goes, the drying of paint combines both of these elements. This will be clear when it is stated that most of the paint used, both for what is technically known as house painting and also for what is known as carriage painting, contains, in addition to the pigment, linseed-oil and japan, varying in amounts, of course, from a very small amount of japan, if it is a good one, in house painting, to a relatively very large amount of japan in some cases of carriage painting; and since, as has already been described, japan contains either turpentine or benzine or both, as volatile constituents, it is easy to see that when the paint is spread on the surface both volatilization of the turpentine and benzine and chemical change of the oil must result before drying is complete.

This is perhaps the place to make clear what we regard as an exceedingly important distinction in the use of dryers in painting. Confining ourselves more especially to japans, since our experience with solid dryers is very small, we find that all japans when added to linseed-oil in the same amounts do not produce drying in the same time, but that each japan has its own characteristic best amount to give the most rapid drying. For example, some japans produce the most rapid drying when the proportions are 95 parts of oil to 5 parts of japan; others give their best results when the proportions are 90 parts of oil to 10 parts of japan by weight. Still others give their best results when 70 parts of oil are treated with 30 parts of japan, and so on. The cause of this variability in the drying power of japans we are hardly able to make clear without occupying much more space than can be devoted to that subject in this article, and so we content ourselves with citing the fact, about which there is not the slightest doubt, as a great many experiments clearly prove.

It follows from this that if less than the best amount of any particular japan is used, the drying will be slower than it would be if the right amount is used. The following fact also follows, and this, to our minds, is very singular—namely, that if more than the right amount of certain japans is used the drying is actually retarded. We are quite well aware that it is customary among painters, if they want to get more rapid drying, to add more japan, and under certain circumstances, which we will explain a little later, this is admissible; but our experience, backed by a very large number of experiments, and also by the testimony of a good many practical painters, is that certain japans will not bear such treatment; in other words, strange to say, a proper amount of certain japans facilitates drying; an increase in amount retards drying. We have studied a good deal trying to explain this peculiarity and to discover not only what japans were characterized by it, but also to find out whether this peculiarity was controllable. In other words, can a japan be made which will behave as above described—namely, when used in the right amount give good results in drying, but when used in larger amount retard the drying, and also can a japan be made which can be used in any amount and give more rapid drying the larger the amount used? We are able to say as the result of our study that both of these ends can be accomplished—that is, we can make a japan which used in a certain amount gives the very best possible results in drying, but which in larger amount causes a retardation in drying, this retardation being a very serious matter. We have actually under test used with exactly the self-same oil and the same method of testing a certain amount of a certain japan, and obtained drying, as above described, in from two to four hours. A larger amount of this self-same japan, every other condition being the same, would not dry in a much longer time. Also we are able to say that a japan can be made which can be used in any amount, and the drying is more rapid the larger the amount of japan used. Our studies still further indicate that the first of these two kinds of japans is the best for facilitating that chemical change in the oil which we call drying; also that the second of these two kinds of japans can be used where the first is not so applicable—viz., under unfavorable conditions, and that it dries mostly by evaporation. Our studies also indicate that most of the commercial japans aim to embody in one japan the good qualities of both—namely, it is hoped, so far as the subject is understood by those making most of the commercial japans, that they give the greatest possible assistance in producing the chemical change called drying, and at the same time can be used under unfavorable conditions by increasing the amount, and thus enable drying to be produced largely at least by evaporation. Our own experience indicates that these two qualities are so diverse, and to a certain extent so antagonistic, that in our final conclusions, in regard to what is the best japan, we have decided to make two japans instead of one, and to make each of them characteristic of one of the two desirable qualities above mentioned. The first we call our standard japan, and this is the most powerful dryer we have ever seen, provided by drying we mean the chemical change in linseed-oil ed-scribed above. The second we call emergency japan, and this, while it does to a certain extent assist the chemical change in the oil called drying, can nevertheless be used in almost any amount, and consequently produces the principal portion of the drying by simple evaporation of the solvent. We have not succeeded in getting satisfactory results with any japan which tries to combine into one these two different modes of action.

We will not attempt in this article to describe how these two kinds of japan are made, since this article is not especially on the subject of japan. It is perhaps sufficient to say that, according to our experience, if it is desired to obtain the most rapid possible drying, and still have the material holding the pigment on the surface almost all linseed-oil, which we may say is the customary recommendation of most practical painters, a certain amount of japan and only a certain amount of it must be used, which japan has the characteristic of facilitating the oxidation of linseed-oil to the maximum. If, on the other hand, there is no question about the material which holds the pigment on the surface, and no special desire to have as much of it linseed-oil as possible, another kind of japan can be used which will given even more rapid drying—that is, a japan which dries very largely by evaporation, since evaporation of solvent in a corresponding thin layer is much more rapid than chemical change. Later on we will give the results of some experiments, showing relative durability of paints, in which the vehicle is nearly all linseed-oil and in which the vehicle is nearly all japan, and will only add here that if the vehicle is almost all linseed-oil, the best that we have ever been able to do is to produce a drying which will bear a second coat in about eight hours under moderately favorable conditions; this with the use of our so-called standard japan. Also that with the use of our emergency japan we have many times been able to second coat in four hours, without difficulty.

In regard to boiled oil, which is a legitimate part of the drying of paint, we will say that, so far as our knowledge goes, two changes are produced in the oil by boiling: First, there is formed in the oil in small amount, varying from 1.00 to 4.00 per cent, lead and manganese soaps, caused by the addition of the oxides of these substances to the oil, and its combination with them during the boiling. Second, there is also probably, and we use the word probably to cover our lack of knowledge on the subject, a certain chemical change introduced in the oil by the action of the heat and the exposure of the oil to the air at a high temperature. Laying aside the chemical changes introduced, it is obvious that the reason why boiled oil dries more rapidly than raw oil is due to the presence of the lead and manganese soaps, as already previously described. Of course we do not wish to be understood as saying that the presence of these soaps is the only element, but simply to indicate that, so far as our knowledge goes, rapid drying is in almost all cases the resultant of having in the oil some solid or liquid dryer. To so great an extent is apparently the drying of boiled linseed-oil a function of the presence of the lead and manganese soaps, that it is customary to make boiled oil at present without ever putting it in a kettle. A small amount of either regular japan or oil dryer is added through the bung-hole of the barrel, giving rise to what is known as "bung-hole boiled oil," and the lead and manganese soaps thus added form a pretty fair boiled oil.

In general we do not favor the use of boiled oil, since we have never been able to secure as rapid drying with boiled oil by any modifications which we could make of it, as we have secured with raw oil and the proper amount of japan. We know there is a strong prejudice among many painters in favor of boiled oil on account of a believed greater durability. We cannot yet give the results of positive experiment on relative durability, but to our minds the difficulties in the way of obtaining satisfactory results in drying from boiled oil are so great that we do not under any circumstances recommend its use.

We will only add that, in our judgment, very little of the so-called boiled oil of the market is made by the old method—namely, by adding litharge and oxide of manganese to the oil in the kettle, and cooking it for a period of time. Of course some manufacturers do this and make a specialty of it, but by far the largest portion of the boiled oil which we have examined is made either by the addition of solid dryers or of japan to the oil in the barrel, or possibly by the addition of japan or oil dryer to the oil in the kettle, and heating moderately for a period of time. In our judgment the bung-hole method is not to be approved, since it is unquestionably a fraud. The party using the oil could equally well obtain the same results by adding the japan to the raw oil. The method of adding japan or oil dryer to the oil in the kettle and then heating it moderately we see no reason to disprove, and indeed we have made a sample of boiled oil in this way which was pronounced by practical men as better than any boiled oil they had ever seen. In the next article we will take up the question of covering power.

The subject of paints and painting is so important, involves so large an expenditure of money by railroad companies, and covers so wide a field, that much space is necessarily required to cover it properly.

(TO BE CONTINUED.)

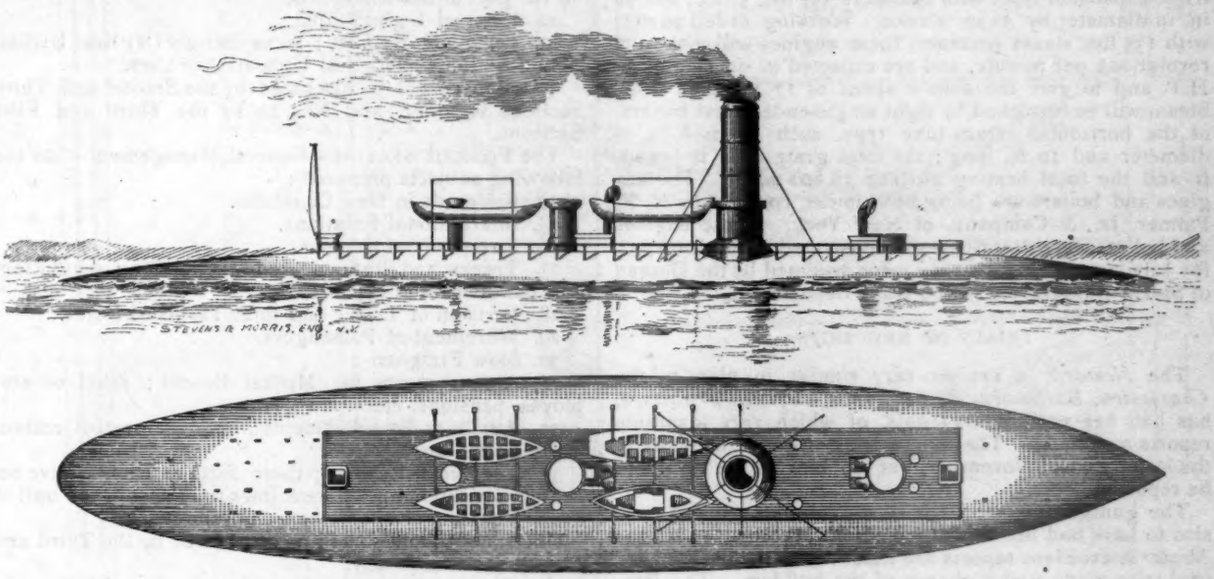
UNITED STATES NAVAL PROGRESS.

So far the new vessels completed and added to the Navy have been all of the unarmored cruiser type, but with the new ships recently put under contract the heavier fighting vessel or battle-ship type will begin to be an element in the new fleet. The first of these will be the reconstructed *Puritan* and the *Monterey*, both coast defense ships, which are making steady progress. These will be followed by the *Maine* and the *Texas*, and later by the three battle-ships just put under contract.

THE HARBOR DEFENSE RAM.

The accompanying illustration shows the general design of the twin-screw armor-plate harbor defense ram—commonly called the Ammen Ram from the fact that it was designed by Rear-Admiral Ammen—for the construction of which bids have been asked by the Navy Department.

The principal dimensions of this vessel are: Length over all, 243 ft.; length on load water-line, 242 ft.; extreme breadth, 43 ft.; breadth at water-line, 41 ft. 10 in.; draft amidships, 15 ft.; displacement, 2,050 tons; indicated H.P., 4,800; speed, 17 knots per hour.



HARBOR DEFENSE RAM FOR THE UNITED STATES NAVY.

The vessel is designed upon the longitudinal and bracket system, with an inner bottom extending from the collision bulkhead to the stern. The longitudinals and girders supporting the deck are to be continuous, converging to the stem casting and to the stern; the frames and beams to be intercostal. The depth of the longitudinals and the vertical keel throughout their length is to be 24 in.; the girders supporting the armored deck are to be 15 in. The vertical keel, two longitudinals, and the armored shelf on each side of the vertical keel are to be water-tight, forming transversely six compartments, which are divided longitudinally by water-tight frames. By this means the space between the inner and outer skin is subdivided into 72 compartments. The transverse and longitudinal bulkheads between the inner skin and deck armor divide this space into 30 compartments, making a total of 102 compartments in the vessel.

The ship is to be provided with a removable wrought-steel ram-head to be accurately fitted and securely held in position in the cast-steel stem.

The framing of this ship will be very heavy and strongly braced. As shown by the illustration, the greater part of the vessel will be submerged, while nearly all of the surfaces appearing above water are curved, leaving no opportunity for a square blow from a shot. The shop will carry no armament, depending entirely upon ramming for her offensive strength.

The outside strake of the deck armor is to be 6 in. thick; the next strake inboard to taper in thickness in its breadth from 5½ to 2½ in., the remainder of the deck plating to be 2½ in. thick, including the lower course. The side armor is to be 2 strakes in depth, the upper 6 in. thick and the lower 3 in., to be secured by bolts with countersunk heads driven from the outside through wooden backing of yellow pine and two backing plates, each 15 lbs. per square foot, and set up with knots and rubber washers. All hatches through the armored deck are to be furnished with battle-plates, and the smoke-pipe and ventilators are to have inclined armor 6 in. thick. The conning-tower is to be 18 in. thick.

The only projections above the deck are the conning-tower, the smoke-pipe, the ventilators, the hatch-coamings, and the skid-beams upon which the boats are supported.

The officers' quarters will be on the after berth deck, and the quarters for the crew will be partly aft and partly forward. There will be a complete installation of electric lights arranged in duplicate. The drainage system will be so arranged that any compartment can be pumped out by the steam pumps. Foul air will be extracted from all parts of the vessel by means of blowers, fresh air being supplied from the main ventilator, through air ducts led along the inside of the deck.

The vessel will be submerged to fighting trim by means of fourteen 8-in. Kingston valves, one in each transverse water-tight compartment of the double bottom. Sluice valves will be fitted in the vertical keel, and the water-tight longitudinals in these compartments.

The engines are triple-expansion and of the horizontal type, each being in a separate compartment. There are four cylindrical horizontal fire-tube boilers placed in two water-tight compartments. The engines are required to develop 4,800 H.P. under forced draft, with a corresponding speed of 17 knots.

LAUNCH OF THE "MAINE."

The armored cruiser *Maine* was launched at the Brooklyn Navy Yard November 18. She is the heaviest ship in weight of guns and armor so far launched for the Navy, and the first of the new fleet built in a Government yard. This vessel has been heretofore described in these columns, but a brief account will be repeated here, for convenience of reference.

The construction of the *Maine* was authorized in 1886, and the plans for the vessel were prepared in the Navy Department. As already stated, she has been built in the Brooklyn Navy Yard, the steel being furnished under con-

tract by Carnegie, Phipps & Company, of Pittsburgh. Work was begun two years ago, and the first keel-plate was laid October 11, 1888. She is an armored cruiser, having a water-line armor belt 12 in. thick, protecting the guns, machinery, and magazines, and extending for 180 ft. of the length of the ship. The general dimensions are as follows: Length over all, 324 ft. 4½ in.; length on load water-line, 318 ft. 3 in.; extreme breadth, 57 ft.; mean draft, 21 ft. 6 in.; displacement, 6,682 tons. She will have three masts, provided with fighting tops.

The main battery will consist of four 10-in. breech-loading rifles, mounted in barbette, with 12-in. steel armor protection to the barbette and 8 in. steel shields over the guns; six 6-in. breech-loading rifles, provided with segmental shields of 2-in. steel. The secondary battery will include four 6-pdr., eight 3-pdr., and two 1-pdr. rapid-five guns, four 37-mm. revolving cannon, and four Gatling guns. There will be also seven torpedo-tubes.

The *Maine* has two three-bladed propellers 15 ft. in diameter, each driven by a separate engine. These engines are of the vertical inverted cylinder, direct-acting, triple-expansion type, with cylinders 35½ in., 57 in., and 88 in. in diameter by 36 in. stroke. Working at full power, with 135 lbs. steam pressure, these engines will make 132 revolutions per minute, and are expected to develop 9,000 H.P. and to give the ship a speed of 17 knots an hour. Steam will be furnished by eight single-ended steel boilers, of the horizontal return-tube type, each 14 ft. 8 in. in diameter and 10 ft. long; the total grate area is 553 sq. ft. and the total heating surface 18,800 sq. ft. The engines and boilers are being built under contract by N. F. Palmer, Jr., & Company, of New York. These engines and boilers were described and illustrated in the JOURNAL for July last, page 305; they were designed by the Bureau of Steam Engineering in the Navy Department.

TRIALS OF NEW SHIPS.

The *Newark*, a cruiser very similar in plan to the *Charleston*, *Baltimore*, *Philadelphia*, and *San Francisco*, has had her preliminary trials, of which very favorable reports are made. The official trials were to be made in the latter part of November, but too late for the results to be reported here.

The gunboat *Concord*, one of the smaller cruisers, was also to have had her official trials in November. Like the *Newark*, excellent reports are made as to the preliminary trial trips made under charge of the builders. The *Bennington*, a sister ship to the *Concord*, will soon be ready for trial.

THE INTERNATIONAL RAILROAD CONGRESS.

THE questions to be discussed by the International Railroad Congress at its next meeting, which will be held in St. Petersburg in 1891, have been announced; they are as follows for the FIRST SECTION—Roadway and Buildings:

1. Nomenclature and Technical Terms; the establishment of an exact and uniform nomenclature.
2. Switches and Crossings.
3. Maintenance of Track; the best system for general adoption.
4. Work of the Wheels upon the Rails; determination of the limit.
5. Relation between Track and Rolling Stock.
6. Track for Fast Trains.
7. Control of the Speed of Trains.
8. Technical Reports; these include the information to be collected on (*A*) Breakage of Rails and Wear of Steel Rails; (*B*) Maintenance of Track with Metal Ties; (*C*) Life of Wooden Ties, both in natural condition and when treated by some preserving process.

The SECOND SECTION—Motive Power and Rolling Stock—will consider the following subjects:

9. Effect of Curves; the best way of providing for their easy passage.
10. Production of Steam.
11. High Boiler Pressures and Compounding.
12. Equipment for Light Railroads.
13. Continuous Heating of Passenger Trains.
14. Regulating Work of Locomotive Engineers; best system for utilizing the locomotives.
15. Technical Reports; these include (*A*) Fuel Consumption in Locomotives; (*B*) Boiler Tubes, best material, cost of maintenance, etc.; (*C*) Tires; (*D*) Lubrication of Locomotives; (*E*) Crank-axles; (*F*) Locomotive Fire-boxes, best material; (*G*) Locomotive Boilers; best material, etc.; (*H*) Lubrication of Cars; (*I*) Yard or Switching engines.

Questions 4, 5, 7 and 9 will be considered by the First and Second Sections in joint meeting.

The THIRD SECTION—Operation—has the following questions assigned to it:

16. Fixed Signals and the Block System.
17. Lighting of Signals.
18. Train Signals; communication between cars and locomotive.
19. Distribution of Empty Cars.
20. Exchange of Rolling Stock.
21. Co-operation in Expediting the Dispatch of Freight on the part of Station-agents.
22. Lines of Light Traffic.
23. Technical Reports; these include (*A*) Best Utilization of Stations; (*B*) Best Utilization of Cars.

Question 18 will be discussed by the Second and Third Sections together, and No. 22 by the Third and Fifth Sections.

The FOURTH SECTION—General Management—has the following subjects prepared:

24. Railroads in New Countries.
25. International Relations.
26. Variations of Gauge.
27. Tracks and Stations used in Common; regulation, and the division of expenses.
28. Division of Traffic and Joint Tariffs of Rates.
29. Movement of Passengers.
30. Slow Freights.
31. Arrangements for Mutual Benefit; relief of employés, pensions, etc.
32. Auxiliary Establishments; management of restaurants, hotels, etc.
33. Technical Reports; these include comparative results of operation on different lines, and cost of the unit of traffic—passenger-kilometer or ton-kilometer.

Questions 29 and 30 will be considered by the Third and Fourth Sections jointly.

The FIFTH SECTION is charged generally with the subject of Light Railroads, including the following questions:

34. Best Gauge for Light Railroads.
35. Steam Power for Light Railroads; especially for local lines or tramways.
36. Rolling Stock.
37. Special Forms of Motive Power; this will include electric railroads and motive power other than steam locomotives.
38. Systems of Management.
39. Legislation; comparison of the laws in relation to Light Railroads in different countries.
40. Light Railroads as Feeders; the use of local lines, tramways, etc., as auxiliaries to main lines; methods adopted by main lines to establish such feeders.

THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C.E.

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(*Continued from page 451.*)

CHAPTER XXIX.

HOWE TRUSS BRIDGES.

IN the accompanying plans, Plate 122 gives a design for a through bridge of 80 ft. span; Plate 123 is a through bridge of 88 ft. span, while Plate 124 contains a number

PLATE 122

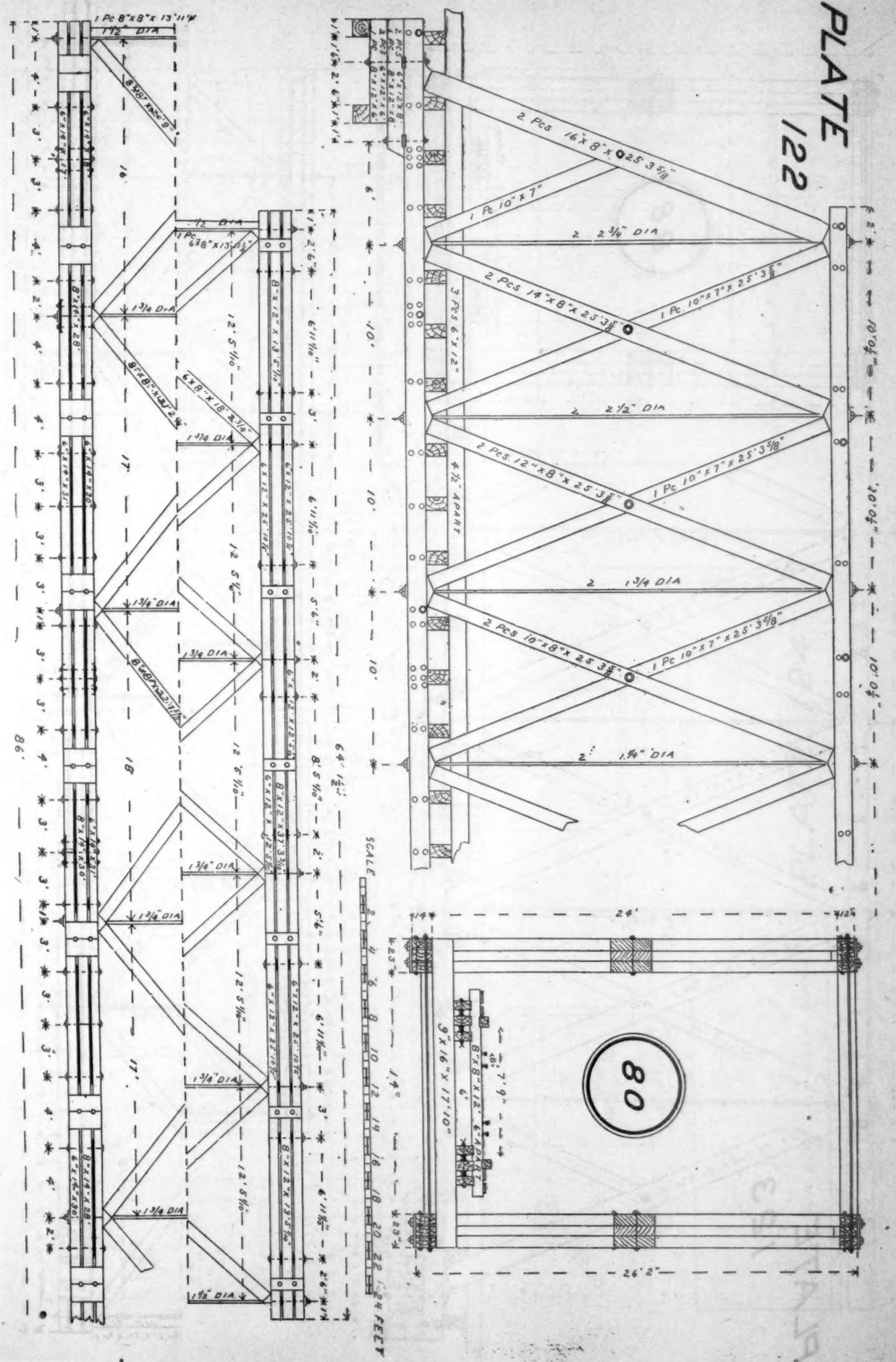
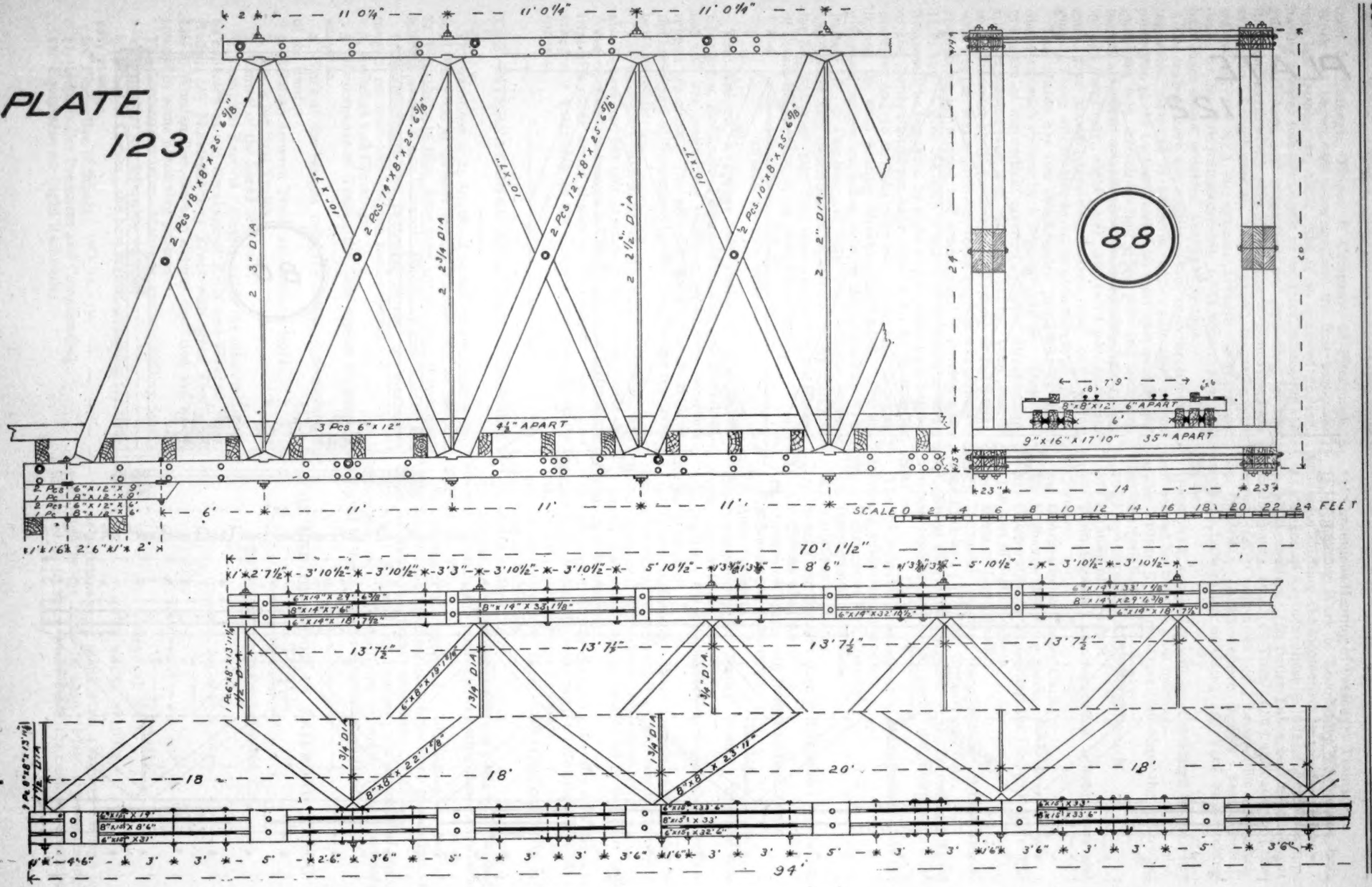

2 Pcs 16"x8"x25'-3 5/8"
1 Pc 10"x7"
2 2 3/4" DIA
2 Pcs 14"x8"x25'-3 5/8"
1 Pc 10"x7"x25'-3 5/8"
2 2 1/2" DIA
2 Pcs 12"x8"x25'-3 5/8"
1 Pc 10"x7"x25'-3 5/8"
2 1 3/4 DIA
2 Pcs 10"x8"x25'-3 5/8"
1 Pc 10"x7"x25'-3 5/8"
2 1 3/4" DIA
3 Pcs 6"x12"
4 1/2" APART
SCALE
24'
26'-2"
9"x16"x17'-10"
80

PLATE 123


11' 0¼"
2 Pcs 18"x8"x 25.6 5/16"
2 Pcs 14"x8"x 25.6 5/16"
2 Pcs 12"x8"x 25.6 5/16"
2 Pcs 10"x8"x 25.6 5/16"
2 3" DIA
2 2¾" DIA
2 2½" DIA
2 2" DIA
3 Pcs 6"x12"
4½" APART
2 Pcs 6"x18"x 9'
1 Pc 8"x12"x 9'
2 Pcs 6"x12"x 6'
1 Pc 8"x18"x 6'
6'
11'
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 FEET
88
7'9"
8"x8"x12" 6"APART
9"x16"x17'10"
35" APART
23"
14
23"
70' 1½"
2'7½"
3'10½"
3'3"
5'10½"
8'6"
13'7½"
18'
20'
94'

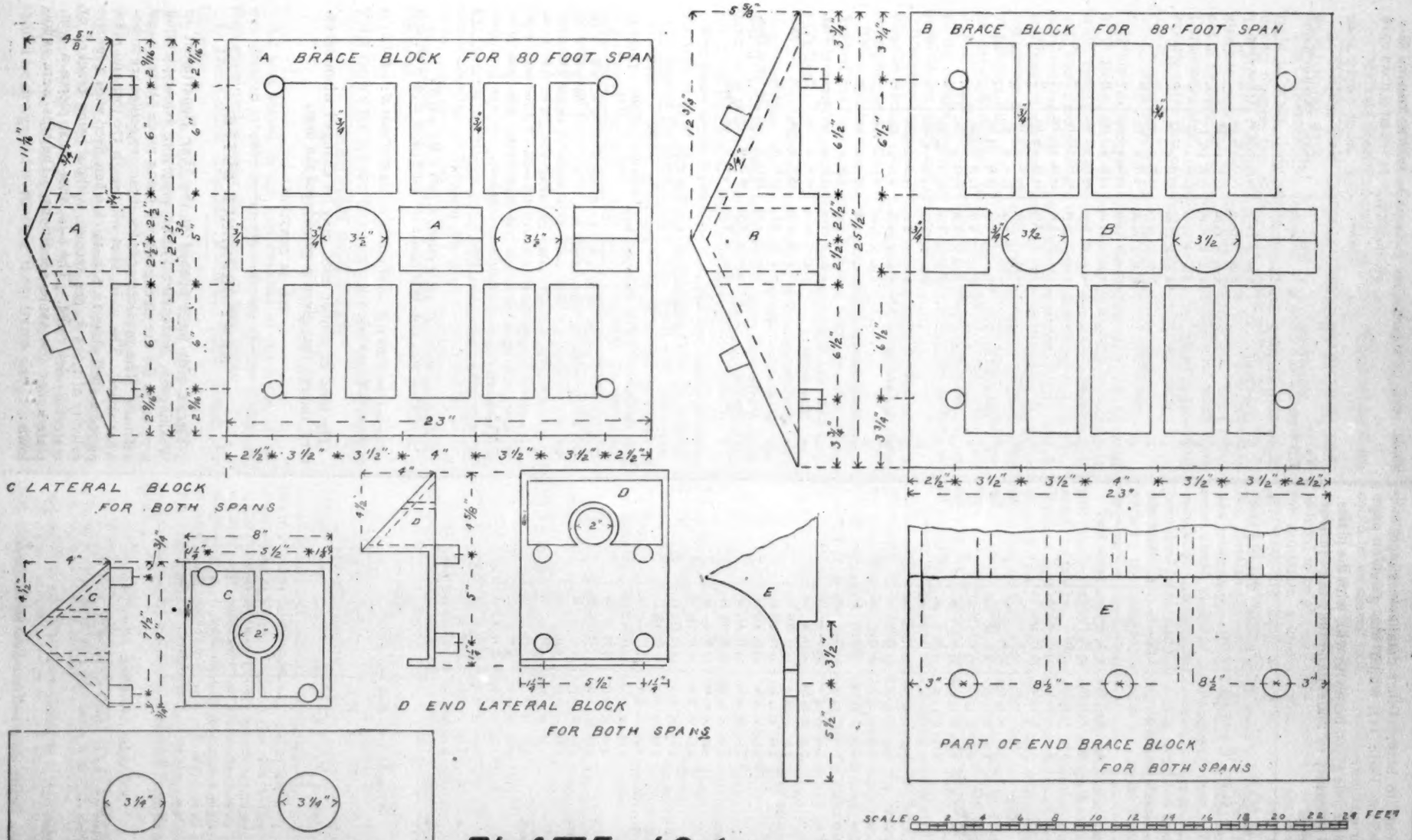

A BRACE BLOCK FOR 80 FOOT SPAN
B BRACE BLOCK FOR 88' FOOT SPAN
C LATERAL BLOCK FOR BOTH SPANS
D END LATERAL BLOCK FOR BOTH SPANS
PART OF END BRACE BLOCK FOR BOTH SPANS
F STRAP FOR VERTICALS BOTH SPANS
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 FEET

PLATE 124

of details common to both. Other details—castings, etc.—will be found on Plate 117, which was given on page 402, September number.

The bill of materials given herewith will, with the plates, give all that is necessary to understand fully the construction of the bridge.

No. 50. Bill of Material for Howe Truss Bridge. Through Span, 88 Ft. Plates 123 and 124.

Timber.

No. of Pieces.	Description.	Size.	Length.	Kind of Wood.
2	Top Chord.....	6 in. × 14 in.	29 ft. 6¾ in.	Yellow Pine.
2	" "	6 in. × 14 in.	33 ft. 1⅛ in.	" "
2	" "	6 in. × 14 in.	7 ft. 6 in.	" "
2	" "	6 in. × 14 in.	33 ft. 10½ in.	" "
4	" "	6 in. × 14 in.	18 ft. 7⅛ in.	" "
2	" "	8 in. × 14 in.	33 ft. 1⅛ in.	" "
2	" "	8 in. × 14 in.	29 ft. 6¾ in.	" "
2	" "	8 in. × 14 in.	7 ft. 6 in.	" "
2	Bottom Chord.....	6 in. × 15 in.	19 ft. 0 in.	" "
2	" "	6 in. × 15 in.	33 ft. 0 in.	" "
2	" "	6 in. × 15 in.	33 ft. 6 in.	" "
2	" "	6 in. × 15 in.	8 ft. 6 in.	" "
2	" "	6 in. × 15 in.	31 ft. 0 in.	" "
2	" "	6 in. × 15 in.	32 ft. 6 in.	" "
2	" "	6 in. × 15 in.	30 ft. 6 in.	" "
2	" "	8 in. × 15 in.	8 ft. 6 in.	" "
2	" "	8 in. × 15 in.	33 ft. 0 in.	" "
2	" "	8 in. × 15 in.	33 ft. 6 in.	" "
2	" "	8 in. × 15 in.	19 ft. 0 in.	" "
8	Braces.....	8 in. × 18 in.	25 ft. 6⅝ in.	" "
8	"	8 in. × 14 in.	25 ft. 6⅝ in.	" "
8	"	8 in. × 12 in.	25 ft. 6⅝ in.	" "
8	"	8 in. × 10 in.	25 ft. 6⅝ in.	" "
12	Counters.....	7 in. × 10 in.	25 ft. 6⅝ in.	" "
4	"	7 in. × 10 in.	14 ft. 0 in.	" "
10	Laterals.....	6 in. × 8 in.	19 ft. 1⅝ in.	" "
2	"	6 in. × 8 in.	13 ft. 11¼ in.	" "
8	"	8 in. × 8 in.	22 ft. 1⅝ in.	" "
2	"	8 in. × 8 in.	23 ft. 11 in.	" "
2	"	8 in. × 8 in.	13 ft. 11¼ in.	" "
8	Bolsters.....	6 in. × 12 in.	9 ft. 0 in.	" "
4	"	8 in. × 12 in.	9 ft. 0 in.	" "
8	Bridge-seats.....	6 in. × 12 in.	6 ft. 0 in.	" "
4	" "	8 in. × 12 in.	6 ft. 0 in.	" "
4	Sills.....	12 in. × 12 in.	18 ft. 0 in.	Spruce or Pine.
26	Floor-beams.....	9 in. × 16 in.	18 ft. 0 in.	" " "
6	Stringers.....	6 in. × 12 in.	94 ft. 0 in.	" " "
81	Ties.....	8 in. × 8 in.	12 ft. 0 in.	Oak.
2	Guards.....	6 in. × 6 in.	94 ft. 0 in.	Spruce or Pine.
4	Planks.....	2 in. × 8 in.	94 ft. 0 in.	" " "
8	Blocks.....	2 in. × 8 in.	2 ft. 0 in.	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
8	Rods.....	3 in.	26 ft. 10 in.	12	Bolster b'lts	1¼ in.	2 ft. 5 in.
8	"	2¾ in.	26 ft. 10 in.	12	" "	1¼ in.	3 ft. 5 in.
8	"	2½ in.	26 ft. 10 in.	52	Fl.beam b'ts	1¼ in.	4 ft. 5 in.
4	"	2 in.	26 ft. 10 in.	64	String'rb'lts	¾ in.	2 ft. 6 in.
4	Laterals....	1⅝ in.	18 ft. 6 in.	54	Tie-bolts...	¾ in.	2 ft. 6 in.
8	" ...	1¾ in.	18 ft. 6 in.	54	G'rd-r'l-b'lts	¾ in.	1 ft. 3 in.
200	Chord-bolts.	¾ in.	2 ft. 0⅛ in.	24	Spikes...	⅙ in.	9 in.
16	Brace-bolts.	¾ in.	2 ft. 0⅛ in.				

Other Iron Work.

Washers (see Plate 117): 800 of pattern *G*; 200 of *H*; 24 of *H* 2.

Castings (see Plate 124): 28 of pattern *B*; 4 of *E*; 16 of *C*; 8 of *D*; 28 of *F*.

Castings (see Plate 117): 10 of pattern *F*; 128 of *I*; 156 of *L*; 48 of *M*; 24 of *N*; 24 of *O*.

Note.—The same packing blocks used for top and bottom chords.

No. 49. Bill of Material for Howe Truss Bridge. Through Span, 80 Ft. Plate 122.

Timber.

No. of Pieces.	Description.	Size.	Length.	Kind of Wood
8	Top Chord.....	6 in. × 12 in.	25 ft. 10¼ in.	Yellow Pine.
4	" "	6 in. × 12 in.	12 ft. 5⅛ in.	" "
2	" "	8 in. × 12 in.	37 ft. 3⅜ in	" "
4	" "	8 in. × 12 in.	13 ft. 5⅛ i	" "
4	Bottom Chord.....	6 in. × 14 in.	31 ft. 0 in.	" "
4	" "	6 in. × 14 in.	30 ft. 0 in.	" "
4	" "	6 in. × 14 in.	17 ft. 0 in.	" "
4	" "	6 in. × 14 in.	8 ft. 0 in.	" "
2	" "	8 in. × 14 in.	30 ft. 0 in.	" "
4	" "	8 in. × 14 in.	28 ft. 0 in.	" "
8	Braces	16 in. × 8 in.	25 ft. 3⅜ in.	" "
8	"	14 in. × 8 in.	25 ft. 3⅜ in.	" "
8	"	12 in. × 8 in.	25 ft. 3⅜ in.	" "
8	"	10 in. × 8 in.	25 ft. 3⅜ in.	" "
12	Counters.....	10 in. × 7 in.	25 ft. 3⅜ in.	" "
4	"	10 in. × 7 in.	13 ft. 8 in.	" "
10	Laterals.....	6 in. × 8 in.	18 ft. 2¾ in.	" "
2	"	6 in. × 8 in.	13 ft. 11¼ in.	" "
4	"	8 in. × 8 in.	20 ft. 9 in.	" "
4	"	8 in. × 8 in.	21 ft. 2¼ in.	" "
4	"	8 in. × 8 in.	22 ft. 1⅝ in.	" "
2	"	8 in. × 8 in.	13 ft. 11¼ in.	" "
8	Bolsters.....	6 in. × 12 in.	8 ft. 0 in.	" "
4	"	8 in. × 12 in.	8 ft. 0 in.	" "
8	Bridge-seats.....	6 in. × 12 in.	6 ft. 0 in.	" "
4	" "	8 in. × 12 in.	6 ft. 0 in.	" "
4	Sills.....	12 in. × 12 in.	18 ft. 0 in.	Spruce or Pine.
26	Floor-beams.....	9 in. × 16 in.	18 ft. 0 in.	" " "
6	Stringers.....	6 in. × 12 in.	86 ft. 0 in.	" " "
74	Ties.....	8 in. × 8 in.	12 ft. 0 .	Oak.
2	Guards.	6 in. × 6 in.	86 ft. 0 in.	Spruce or Pine.
4	Planks.....	2 in. × 8 in.	86 ft. 0 in.	" " "
8	Blocks.....	2 in. × 8 in.	2 ft. 0 in.	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
8	Rods... ...	2¾ in.	26 ft. 10 in.	12	Bolster b'lts	1¼ in.	2 ft. 4 in.
8	"	2½ in.	26 ft. 10 in.	12	" "	1¼ in.	3 ft. 4 in.
8	"	1¾ in.	26 ft. 10 in.	52	Fl.beam b'ts	1¼ in.	4 ft. 4 in.
4	"	1¼ in.	26 ft. 10 in.	56	String'rb'lts	¾ in.	2 ft. 6 in.
4	Laterals....	1⅛ in.	18 ft. 6 in.	48	Tie-bolts.	¾ in.	2 ft. 6 in.
8	" ...	1¾ in.	18 ft. 6 in.	48	G'rd-r'l-b'lts	¾ in.	1 ft. 3 in.
192	Chord-bolts.	¾ in.	2 ft. 0⅛ in.	2	Spikes.....	⅙ in.	9 in.
16	Brace-bolts.	¾ in.	2 ft. 0⅛ in.				

Other Iron Work.

Washers (see Plate 117): 750 of pattern *G*; 160 of *H*; 24 of *H* 2.

Castings (see Plate 124): 28 of pattern *A*; 4 of *E*; 16 of *C*; 8 of *D*; 28 of *F*.

Castings (see Plate 117): 10 of pattern *F*; 112 of *I*; 56 of *K*; 108 of *L*; 44 of *M*; 22 of *N*; 22 of *O*.

The kind of timber used may be changed when necessary, though that given is considered the best.

(To be continued.)

ARMY ORDNANCE NOTES.

Three bids were opened at the War Department in Washington, November 13, for supplying armor-piercing projectiles for the steel guns now being made for sea-coast defense. The requirements for these projectiles are somewhat strict. The 10-in. shot will weigh 570 lbs. and must pierce a steel plate 11.2 in. thick when fired with a muzzle velocity of 1,625 ft. per second, without being cracked or materially deformed. The 8-in. shot must pierce a 9-in. plate under the same conditions. The bids were as follows :

1. Carpenter Steel Company, Reading, Pa., 8-in. shot, $150 each; 10-in. shot, $285 each.
2. Midvale Steel Company, Midvale, Philadelphia, 8-in. shot, $150; 10-in., $287.
3. Sterling Steel Company, Pittsburgh, Pa., 8-in. shot, $300; 10-in., $575.

The Carpenter Steel Company, it is said, has secured the right to make these shells under the Firminy process in use in Europe, but declines to make public any details. The Midvale Company has a process of its own, which is also kept secret. The Sterling Company also has a process of its own, and intends to use crucible steel made from Dannemora iron. It will be noticed that its bid was almost exactly twice that of either of the other companies.

THE REPORT OF THE ORDNANCE BUREAU.

In his yearly report to the Secretary of War, General S. V. Benet, Chief of the Bureau of Ordnance, says that while extensive experiments have been carried on abroad with smokeless powders, and some astonishing results have been obtained, yet difficulties have been developed which still make it uncertain whether these will replace the present service powder. The Department has so far been able to procure only very small samples, and while some experiments have been made with them in small arms, the lack of a sufficient quantity has prevented the perfecting of all the details of the new 0.30-caliber rifle; but as soon as possible the work will be continued.

It is recommended that a Board be appointed to select a suitable mechanism for a magazine rifle to replace the present Springfield rifle.

The appropriation for the gun factory at the Watervliet Arsenal has been expended and the work of completing the plan to give an output of 24 heavy guns yearly is well advanced.

Work under the contracts with the Pneumatic Dynamite Gun Company has progressed slowly. Most of the materials for the guns intended for New York and Boston have been procured, but work on the guns intended for San Francisco has not been commenced.

The plans of the Fortification Board included the manufacture of 44 of the new 16-in. seacoast guns, 36 of them to be used in the three ports of New York, San Francisco, and Boston. These guns are to be mounted in pairs in turrets so placed as to command the principal water approaches of the port. The total length of the proposed 16-in. gun is about 49 ft. 6 in.; the length of the bore 35 calibers, and the weight 125 tons. One of these guns will have a charge of about 1,000 lbs., with a projectile of over one ton in weight. The estimated muzzle penetration in iron is about 3 ft. and the maximum range 15 miles.

Among the appropriations asked for are $125,000 for steel forgings for one type sea-coast gun of 16-in. caliber; $325,000 for carriages for 12-in. mortars; $200,000 for armor-piercing projectiles; $1,250,000 for steel for 8-in., 10-in., and 12-in. guns; $708,743 for the new south wing at Watervliet Arsenal and for cranes and other tools for the same.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

As was stated in the July number of the Journal, it was decided in 1887 by the Commission of four Ministers then appointed to order the survey of four lines:

1. The Central Siberian Railroad, from Tomsk to Irkoutsk.
2. The Trans-Baikal, from Lake Baikal or some point on its tributary, the Selenga River, to some point on the Amour River or its tributary, the Shilka.
3. The Oussouri Railroad, from the Oussouri River to Vladivostok.
4. The Baikal Loop Line, around Lake Baikal either to the north or to the south, connecting lines 1 and 2.

Concerning the traffic capacity of the Great Siberian Railroad, the Commission considered it sufficient that it should be designed for running three trains daily in each direction, at a speed of 16 miles an hour, the road, however, to be so constructed that the number of daily trains could be increased to seven without difficulty.

As the line will traverse a country of very varying topography, the technical conditions and specifications were ordered to be of two kinds: for plain or level sections and for mountain sections. For level sections the ruling gradients are fixed at 0.8 per cent. and the minimum radius of curvature 1,750 ft.; the weight of rails to be 54 lbs. Russian (49 lbs. English) to the yard. For the mountain sections the ruling gradient was fixed at 1.5 per cent., exceptional sections to be 2 per cent. The minimum radius of curvature was placed at 1,050 ft., 840 ft. to be permitted in exceptional cases, provided that the sharpest curvature and the heaviest grades should not come together; the weight of rails to be 60 Russian lbs. (54½ English lbs.) to the yard.

The other specifications were made similar to the standard requirements of the Russian State Railroads, but with some relaxation. The gauge, of course, was fixed at the Russian standard of 5 ft. The width of grade was to be at least 14.4 ft.; the length of ties, 8 ft., and the quantity of ballast at least 2,300 cub. yds. per mile. The bridges might be of wood unless, according to local conditions, iron and masonry would be cheaper; for the large rivers, such as the Yenesei, steam ferries might be used instead of bridges.

These conditions, which were elaborated by the State Railroad Direction, were endorsed by the Commission of Ministers, and were made part of the instructions given by the Minister of Roads and Communications to the Chief Engineers of the three expeditions, which were appointed to make the surveys of the different lines. The cost of these three surveys was estimated as follows:

Line.	Cost of Survey in Roubles.	
	Total.	Per Mile.
Central Siberian Line.....	225,000	200
Trans-Baikal Line	157,000	215
Oussouri Line.....	120,000	450
Total.....	502,000	....
Reconnoissance of Baikal Loop Line...	12,000	....

After the instructions had been confirmed and the money credit allowed, the following Chief Engineers were appointed for each expedition: N. P. Mejeninov, C.E., for the Central Siberian Railroad; O. P. Viazemski, C.E., for the Trans-Baikal Line; and A. O. Oursatti, C.E., for the Oussouri Railroad. The surveys for the Central Siberian and the Oussouri Lines were made in the years 1887–88, and for the Trans-Baikal Line in the years 1888–89.

After this preliminary general statement the results of the work of each expedition will be given separately.

I.—THE CENTRAL SIBERIAN RAILROAD.

According to the instructions given, the general location of this line started from Tomsk on the river Tom, a tributary of the Obi, and following more or less closely the present post road, passes through Mariinsk, Achinsk, Krasnoiarsk, and Kansk to Irkoutsk. The location is shown on the accompanying map; the general situation of this section may be seen on the map of Siberia published in the June number of the Journal, page 259.

The whole length of this line from Tomsk to Irkoutsk is 1,038 miles, or 1,048 miles including branches to the river ports or landings.

In consequence of the varying character of the country, it was necessary to divide this line into five sections, as follows:

1. From Tomsk to Achinsk, 256 miles.
2. From Achinsk to Krasnoiarsk, 115 miles.
3. From Krasnoiarsk to Nijne-Oudinsk, 355 miles.
4. From Nijne-Oudinsk to Oukhtouisk, 158 miles.
5. From Oukhtouisk to Irkoutsk, 164 miles.

Of these sections the first and fourth are level, the second and third mountain sections, while the fifth runs

through a mountain country from Oukhtouisk to Polovinnaia, but from that point to Irkoutsk is level.

On this line it was arranged to make the greatest distance between water stations 19 miles, which, with an average speed of 16 miles an hour, would permit the running of seven daily trains each way; but the sidings or passing places at present are placed 33 miles apart, permitting the running of three trains only each day. In case, however, more trains should be needed, additional sidings can easily be put in.

The level sections have the ruling grade 0.8 per cent and the minimum radius of curvature 1,750 ft., although at some points the gradient was increased to 0.9 per cent., but on this grade the minimum radius of curvature was not in use. This condition satisfies the requirement that a train of 30 freight cars, weighing about 300 tons, can be hauled by one standard 36-ton engine.

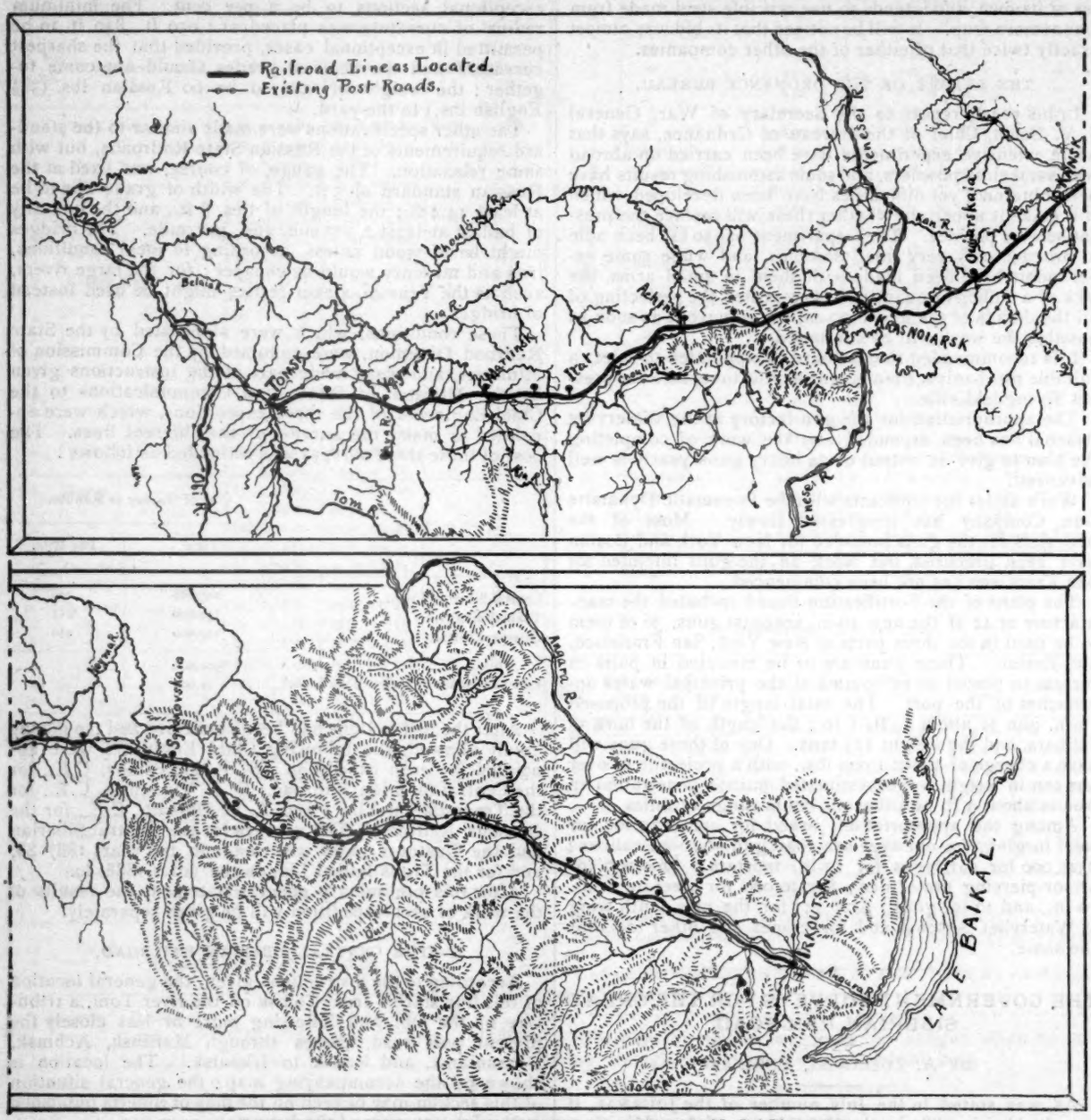
The first section from Tomsk to Achinsk, as already stated, was a level section, but the branch extending from the Tomsk Station to the port or landing on the Tom River has grades of 1.5 per cent., with curves of 840 ft. and 1,050 ft. radius.

The conditions of the mountain sections—limiting grades of 1.5 per cent. and minimum radius of curvature 1,050 ft.—were applied to the sections from Achinsk to Krasnoiarsk; from Krasnoiarsk to Nijne-Oudinsk, and from Oukhtouisk to Polovinnaia, making a total of 503 miles, all in very rough mountain country. At each end of each of these sections is located a division station with engine-houses. The Yenesei River is crossed near Krasnoiarsk.

The location of the line from Achinsk to Irkoutsk was very difficult, since the line, following a general direction to east and southeast, was obliged to cross the ridges or ranges dividing the valleys of the Siberian rivers, which here all flow from the Saian Mountains, and run northward in the same direction as the ranges of hills which separate them. On this part of the line there are 15 of these divides, some of them rising to a height of 980 ft. above the valleys.

While the grade of this section was designed for single track only, the road-bed is made in open country 16.8 ft. in width; in wet or marshy lands 18 ft., and in cuts 15.4 ft.

The average quantity of earthwork required is estimated at 35,500 cub. yds. per mile.



LOCATED LINE OF THE CENTRAL SIBERIAN RAILROAD.

A distinguished feature of the Great Siberian Road is the great number of river crossings required. The line will cross the following, which may be called great rivers, requiring bridges of lengths varying from 175 ft. to 1,400 ft.: The Kitat, a tributary of the Yaya; the Yaya and the Kaya, tributaries of the Chulim; the Chulim, a tributary of the Obi; the Great Kemchoug, a tributary of the Chulim; the Kacha, a tributary of the Yenesei, which is ¼ mile wide at the crossing; the Little Ouria and the Great Ouria, tributaries of the Kan; the Kan; the Poija, the Reshety and the Koutorka, tributaries of the Birusa; the Birusa, a tributary of the Yenesei; the Kamenna, the Poganka, and the Ouda, tributaries of the Chouna, which belongs to the Yenesei system; the Kourzam, a tributary of the Ouia; the Ouia, the Oka, the Zalaria, the Balaia, and the Kitoi, all tributaries of the Angara, which is the outlet of Lake Baikal, flowing from that river and falling into the Yenesei.

The bridges over these rivers are all designed to have iron superstructure and masonry abutments and piers. Masonry will be necessary in view of the thickness of the ice which forms upon the rivers in Siberia, but in the beginning the superstructure of some of them may be of wood. The smaller bridges and viaducts or trestles will also be built of wood, the intention being to use wooden structures with masonry abutments. In some cases cast-iron culvert pipes of 3½ ft. diameter will be used, and there will also be a number of masonry culverts from 7 ft. to 14 ft. span. No less than 40 caisson foundations will be required.

The number and sizes of the iron bridges will be as follows:

No.	Kind of Bridge.	Span.	Total length.
31	Deck truss spans.....	70 ft.	210 ft.
6	Through truss spans.....	70 "	420 "
2	Through truss spans..	84 "	168 "
2	Deck truss spans.....	105 "	210 "
3	Deck truss spans.....	140 "	420 "
10	Deck truss spans.....	175 "	1,750 "
29	Through truss spans.....	175 "	5,075 "
3	Through truss spans.....	210 "	630 "
5	Through truss spans.....	245 "	1,225 "
10	Through truss spans.....	280 "	2,800 "
73	....	.....	12,908 ft.

The 10 spans of 280 ft. are designed for two bridges, each of five spans, one over the Kan River and the other over the Birusa. The total weight of iron required for the superstructure of all the bridges will be 15,000 tons.

The bridge over the Yenesei will require 11 spans of 350 ft. each, but it is not included in the table above because the intention is for the present to use a steam ferry, which, it is believed, will be more economical and will cost about 600,000 roubles.

As noted above, there will be required 2,300 cub. yds. of ballast per mile, and the ties will be 8 ft. in length; they will be cut and delivered along the line by teams. The total length of sidings will be 7½ per cent. of the length of the main track. As the rails are somewhat light—54 lbs. Russian, or 49 lbs. English, to the yard—a large number of ties will be used, the estimate being for 2,446 per mile.

The smaller buildings of the road will be constructed, as is very common in Siberia, of wood, with foundations of wooden crib work. The track watchmen will be stationed two miles apart and the section-men at convenient distances, so that there will be required 525 watchmen's houses and 273 section-houses. There will be in all 69 stations built of the type generally adopted on the State Railroad, three being rated as of the second class, 12 of the third, 24 of the fourth, and 30 of the fifth class. The greatest distance between stations on level sections is 19 miles, and on mountain sections it is 17½ miles. As the six-wheel or passenger locomotives have a tender capacity of 300 cub. ft., and the eight-wheel or freight locomotives of 400 cub. ft. of water, this will be sufficient. For the present at the fifth-class stations there will be provided only water tanks, but no sidings. The latter will be put in as the traffic increases sufficiently to require it.

The station buildings will be of wood, placed on masonry foundations and with sheet-iron roofs. The house for officers and employés will be also of wood on masonry foundations. There will be three separate freight stations, one in Tomsk, one in Krasnoiarsk, and one in Irkoutsk.

There will be 15 engine-houses of quadrangular form, and it is calculated that four-fifths of the engines will be in the engine-house at one time. In consequence of the cold climate of Siberia the engine-drivers will not run more than 100 miles at a time, and it will also be necessary to have the houses well heated. The repair shops at present will be on a small scale. They will be of masonry, with sheet-iron roof.

As to water-supply, suitable sources, as lakes, rivers, springs and wells, are found in abundance at every point where it is needed. In order to prevent difficulty from freezing, the conducting pipes have to be placed at least 10½ ft. deep and covered with ashes, birch bark, or some other poor conductor of heat. The standard water tank is of boiler plate, having a capacity of 3,072 cub. ft., and they are to be placed with the bottom elevated at least 21 ft. above rail-level. At each engine-house there will be a tank with double the ordinary capacity, and hydraulic and other cranes will be placed where needed.

There will be 15 turn-tables of the Sellers pattern at the 15 principal stations. These will be 55 ft. in diameter, and there will also be required five small turn-tables for cars and three weighing bridges. The station yards will be supplied with the necessary sidings, switches, and signals, but will not be generally paved or fenced, except at the principal points.

The cost of the Central Siberian Line, 1,048 miles in all and not including the Yenesei Bridge, is approximately estimated at 68,680,000 roubles, or 65,534 roubles per mile. This is equivalent to about $35,000 per mile, which does not seem a large estimate in view of the great amount of mountain work and the fact that much of the material will have to be conveyed long distances.

(TO BE CONTINUED.)

STEAM-HEATING OF PASSENGER TRAINS ON THE PENNSYLVANIA RAILROAD.

(Paper read before the Franklin Institute, Philadelphia, by Mr. Theo. N. Ely, General Superintendent of Motive Power, Pennsylvania Railroad.)

SEVERAL requests have been made for a description of the passenger-car steam-heating system with which the Pennsylvania Railroad has been experimenting.

Much attention has been given to the broad question of car heating by water and steam for several years, and the process of elimination has confirmed the belief on our part that the return system is the one which must finally prevail if the best results are desired; whether the arrangement which is now being applied to the cars of the Pennsylvania Railroad is the best that can be devised can only be determined by a longer service than has yet been possible.

Briefly, a return system is one which, by the aid of a pump or other vacuum-producing device, brings back to the tender of the locomotive the water of condensation derived from the steam which has given up its heat in warming the cars.

In the Pennsylvania system—see diagram given herewith—an ordinary pump is used as a means of obtaining the necessary vacuum, and is located conveniently on the inside of the tender.

The steam to supply the system is taken from the bridge-pipe of the locomotive and passes into a reducing valve *A* where the pressure is reduced to about 40 lbs.; it then crosses over to the tender by means of a hose-pipe and enters a second reducing-valve *B*. The first of these valves is set to protect the hose-pipe, the latter to protect the train from extreme pressure.

Before the steam enters this second reducing-valve, a branch is taken off to drive the pump *C*, and on the other side of the valve the exhaust steam from the pump connects, so that this steam may be turned in to heat the train.

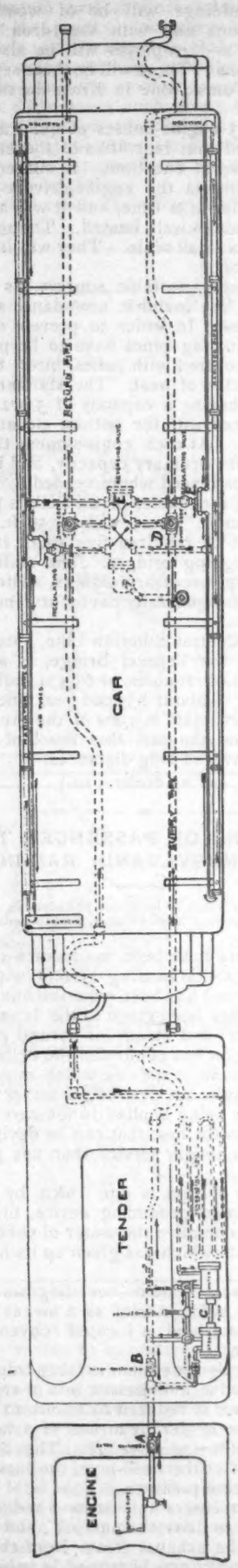


DIAGRAM OF STEAM-HEATING ARRANGEMENT, PENNSYLVANIA RAILROAD.

Leaving the second reducing-valve, the supply-pipe runs to the back of the tender and here crosses over and connects with the main supply-pipe under the car; this pipe runs the entire length of the car and connects to the next car, and so on, forming, when the train is coupled up, a supply-pipe running the entire length of the train.

In the center of each car a branch leaves the main pipe to supply the car with steam; at this point a three-way cock *D* is placed on the main pipe and arranged so as to allow the steam to flow along the main pipe and into the branch at the same time; this is the same in all of the cars, except the last, where it is turned in such a position as to allow the steam to flow into the branch pipe only, further communication back of this on the main pipe being cut off. This cock is operated from the inside of the car, and obviates the necessity of placing a cock at each end of the pipe, which cock when closed, as in the case of the rear of the last car, forms a pocket in which the condensed water may freeze; the main pipes leading through this three-way cock have a pitch to either end, and are so arranged that when uncoupled they will drain themselves. This branch pipe conducts the steam to a reversing valve *E*, which will be explained later on; by means of this the steam is distributed to both sides of the car, the two pipes conveying this steam coming up through the floor on opposite sides of the car and connecting with regulating-valves *F* placed to control the heat; these two valves stand, one on either side of the aisle, under the center of the seats, and are very easily operated without disturbing passengers.

The arrangement of radiators, pipes, etc., inside the car on both sides are exactly the same, both sides being operated independently, so that in case of a leak it is only necessary to shut the steam off one side.

The regulating-valve is the highest point reached, the pipes being so arranged that any condensed water that may accumulate will find its way out when the cars become uncoupled. From the regulating-valve, the steam is conducted by a ¾-in. pipe to the radiators, which are located in the corners of the car, and from them back to the center, by means of a cast-iron radiator-pipe 2 in. wide, 4 in. high, with radiating ribs 1 in. apart; these pipes are bolted together in lengths of about 6 ft.

In the center length of the cast-iron pipe, the exit for the condensed water is placed; this is a foot lower than the regulating-valve, so arranged that all the water condensed in the radiators, etc., will find its way to this point.

A piece of 2-in. wrought-iron pipe, capped, is screwed into the cast-iron radiator-pipe under each seat to give additional heating surface; the object is to condense as much of the steam in the radiators as possible, and this is done by throttling the exit from the cast-iron pipe. The two exits are connected with the reversing valve by two pipes which go through the floor and are brought by the reversing-valve again into one pipe. The arrangement from this point is the same as in the supply-pipe—namely, the pipe leaving the reversing-valve connects with a three-way cock situated on the main return-pipe, which runs the entire length of the car, and on the ends of which the couplings are placed, forming again when coupled a main return-pipe running the length of the train; the object of the three-way cock here is the same as in the former case, and it is operated from the inside of the car.

This return-pipe connects with the suction end of the pump, so that all of the condensed water is so drawn out of the system into the return-pipe, which conducts it to a condensing coil in the tank, to insure all of the steam being condensed before entering the pump; after passing through the pump it is discharged into the tank.

Reference was made some time back to a reversing-valve *E*; the conclusion that will have been drawn from the foregoing is that there are two main pipes under each car, one a supply, the other a return.

Should a car or train be reversed, the pipes will change places—that is, instead of having the supply-pipe on the left-hand side, it will be on the right-hand side; the object of the reversing-valve is to obviate this difficulty, and it is so arranged that by a simple movement, from inside the car, the pipe that was performing the duty of a supply will now perform the duty of a return. Another important

feature of this valve is that by further movement a connection is made with the exit from the radiator-pipes to the atmosphere, thereby changing the system to a direct one; the advantage of this is that, in the event of the pump failing, it would be the work of a minute to set the valves for the direct steam. Again, should it be necessary to couple one of these cars to a train fitted with the direct system, it would work equally well. The couplings used are what may be termed as "male and female," and so arranged that one of the same kind is on opposite diagonal corners of the same car; the male coupling is attached to the main pipe by means of a rubber hose-pipe in the form of an S in a horizontal plane, which allows for all of the movements between the cars, while the female is screwed on the main pipe on the opposite side.

The male coupling has placed on it a spiral spring enclosed in a case, movable on a longitudinal direction; upon this case are placed two trunnions; the female coupling has fastened to its end a joint ring for making it tight against the end of the male coupling; upon it are also placed two trunnions which serve as the hinges for the latch. This latter consists of a forked bell-crank fulcrumed upon the trunnions, and has its short arms furnished with recesses arranged to engage with trunnions on the male coupling.

When two cars are brought together, the latches are thrown back and male and female couplings brought end to end; a movement of the latch in opposite directions causes the recesses on the short arms of the latch to engage with the trunnions on the male coupling, the two arms brought tight against each other, and in so doing the spiral spring is compressed, which allows for small variations in length of the couplings, and insures the same pressure between their faces.

The long arm of the latch is fastened by means of a chain to the platform of the car upon which the male coupling is placed, and this chain is made of such length that when the cars are uncoupled, it will pull the latch over and release the steam coupling.

The operation of the system is clearly indicated by the arrows of the diagram.

The problem of heating a train on a cold day is a simple one as compared with that of heating a train on a mild day. It will be understood that the direct system requires steam at some pressure for distribution, and so in the pipes there can never be a temperature of less than 212°.

With such a temperature on a mild day it is difficult to regulate the temperature of the cars. The Pennsylvania Railroad Company has arranged the system so that in mild weather only the exhaust steam from the pump is used; the pump creates a vacuum, and this exhaust steam passes through the system in the form of a vapor, making it comparatively an easy matter to maintain the temperature at not more than 1° above the atmosphere, if necessary.

The pressure in the radiator-pipes, etc., inside the cars, varies from zero to one-half pound; this latter pressure is required in the coldest weather only.

It is, therefore, obvious that in case of accident there would be absolutely no danger from escaping steam.

The following data, taken from several trains running part of last winter, will indicate the general condition of service:

Average pressure on supply pipe	2.5 lbs. per sq. in.
" pressure in radiator-pipes	zero.
" vacuum	23 in.
" temperature outside	32°.
" temperature inside cars	70°.
" number of cars	5.

When it is necessary to heat a train quickly, the pump is started and a pressure of 20 lbs. is turned into the train-pipe; this will raise the temperature 15° to 20° every five minutes.

When the car becomes warmed to the required temperature, the pressure is reduced to the normal working.

Cars when once heated are found to retain their heat for considerable time. Ten minutes before the train arrives at its destination, it is usual to shut off all the steam from the train; the pump is kept going to draw all the water out of the system, so that when the couplings are undone, there are seldom more than a few ounces of water to come out.

In connection with the heating, much care has been given to secure ventilation, and with the following simple arrangement excellent results have been obtained.

Beneath the cast-iron radiator-pipes are placed a series of air-tubes, one under each seat; these make a connection with the outside air through a 2-in. opening. The hot air rising from the radiator-pipes naturally draws the fresh air in from these tubes, which becomes heated, and rising up passes out through the deck ventilators, inducing a current of warm, fresh air, which is made to pass through the car at all times.

An experiment was made with a train of 12 cars, and most favorable results were obtained, clearly demonstrating that the system is quite capable of heating any train running, or that would be likely to run.

In the return system, the steam taken from the boiler does not seem to affect the steaming of the locomotive; considerable trouble has been experienced in this respect, when using the direct system with heavy trains.

During the winter of 1889–90, 70 cars were put in use and performed satisfactory service.

There are a number of constructive details of the system described which can undoubtedly be simplified, as more experience is gained from actual operation.

THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

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I.—EARLY DEVELOPMENT.

Although the War of the Rebellion was fought in large measure, on both sides, with half-trained armies, with improvised navies, and, in many directions, with makeshift material, it nevertheless taught more lessons of practical military value than any war that has occurred in many generations.

Not the least among these lessons was that of the value of torpedoes or submarine mines in the defense of a harbor or seaport. In fact, so important a factor did these contrivances become that, so far at least as the Confederates were concerned, they passed from the ordinary rôle of subordinate or auxiliary to that of chief means of defense.

It would not, of course, be true to say that the submarine mine had its birth during the Civil War. On the contrary, the resort to auxiliary means of defense against an enemy's ships is as old as human history, for the modern torpedo or mine has its prototype in the fire-ships of the Greeks and Romans, and is used precisely for the same purpose. Later on, when gunpowder came into general use, mine ships and powder boats were substituted for destroying the ships or damaging the defensive works of an adversary. But up to the time mentioned, the use of all such contrivances had been marked with but indifferent success, and, it may be added, the use of hidden mines was generally considered, along with chainshot, explosive bullets, etc., as barbarous and unworthy of civilized nations.

The American Revolution brought forward, in the person of David Bushnell, the pioneer in submarine mining, or rather the first inventor who seems to have understood the part played by water-pressure in calculating the effects of subaqueous explosions. He devised a submarine boat and a number of mines, floating and otherwise, but achieved no practical results—the attempted and almost successful demonstration against a British sixty-four, off Governor's Island, being the nearest approach to success he attained.

Robert Fulton and Samuel Colt both did much toward the development of torpedo warfare; both gave time and money freely in pushing their inventions; both received Government appropriations to enable them to carry on ex-

periments. But Government support failed in the end, and researches in this direction were abandoned—the one turning his attention to the steamboat, the other to the manufacture of fire-arms.

During the Crimean War the Russians, for the defense of their Baltic and Black Sea ports, used submarine mines extensively, but they were too small in size (usually charged with 20 lbs. of gunpowder) to do much actual damage, although the moral effect was sufficient to secure a number of their ports against attack by the allied fleet. In fact, in every great war since the beginning of the century, wherein maritime people have been involved, efforts have been made to utilize the submarine mine for defense, but the means and material at hand have been so inadequate to meet the exacting conditions their effective employment imposes, that it is very certain no great success could have been attained even had they been brought to the test of battle.

As a means of defense, mines have, of course, always had a value, but it was not until slow sailing craft, dependent on wind and tide, had given place to swift steamers, and later on to the modern armored fighting ship, of high speed, and practically invulnerable to fire delivered against her under existing conditions, that the necessity became imperative for some means of holding an enemy at a distance, at arm's length, so to speak, long enough to bring into effect the full artillery power of the defense.

This is the rôle of the submarine mine and the torpedo. So important have they become that no arrangements for the defense of a harbor or water-way is now considered complete without a system of mines. But to properly put down and care for such a system requires careful preparation in the beginning, and constant and vigilant supervision afterward, as well as provision for its certain operation in the hour of need. Such devices must always be subordinate to guns on shore, for if left to themselves, an enterprising enemy can always, with the means now at hand, neutralize or destroy them with little danger to himself.

II.—HOW CLASSIFIED.

As used in a military sense, the general term of torpedo was formerly employed to designate all explosive devices designed to act destructively against an enemy. As at present understood, this term applies to all *offensive, movable* contrivances of this kind. Those that are stationary and defensive are designated as mines, or submarine mines, where used in harbor defense.

Submarine Mines are divided into two general classes—Automatic and Controllable, which terms indicate with sufficient clearness the distinctive features of each.

An *Automatic, or Self-acting Mine* can only be fired by contact, and when once placed in position and rendered active by the removal of its safety-pin or plug, is entirely beyond control, and acts only when struck with sufficient force to set its igniting device in motion. Such a mine may be either *mechanical* or *electrical*. If mechanical, it is provided with some device for mechanically igniting its charge, as a falling weight, either within or without its case; a released spring actuating a hammer, or by a chemical fuse rendered active by concussion. If electrical, a small battery is used, which may be enclosed within the mine itself, within its anchor, or placed upon the bottom some distance away. The blow from a ship or a heavy body is made to close the firing circuit and ignite the fuse.

A *Controllable Mine* is one provided with proper electrical apparatus, and is always under absolute control. Such a mine may be set to be exploded automatically on contact with a vessel, or at will from the shore, and can at any time be rendered harmless by cutting out the firing battery. It possesses the further great advantage that it can be tested and its condition ascertained at any time.

An *Automatic Mine* has the advantage of being easily constructed and planted; it can be prepared beforehand, put in store and placed in position when needed, and its manufacture and manipulation does not require skilled labor. On the other hand, when once in position it bars a harbor against friend and foe alike; it is more or less dangerous to handle, and there is no method by which it can be tested and its condition ascertained.

As to the manner of mooring, a further division is made into *Ground* and *Buoyant* mines—their names indicating that the one is placed upon the bottom of the channel, serving as its own anchor, while the other, by means of an anchor and a connecting cable, is made to float at any required distance below the surface.

Torpedoes are of two general classes—Uncontrollable and Controllable. As its name indicates, the latter class includes every torpedo which when once put in motion passes entirely beyond the control of the operator. It may be fired from a gun like a projectile; from a tube like a rocket; may be sent to drift against its object with tide or current, or carry within itself the mechanism necessary for its locomotion.

A Controllable torpedo is one that maintains during its entire course mechanical or electrical connection with the operating station, and is under complete control of the operator. It may be attached to a spar and thus directed against its object; may be towed on divergent lines by a boat or vessel, or be driven on its course by power supplied from the sending station by an electric cable or by mechanism contained within itself. In either case its course is directed from the shore.

III.—AS USED BY THE CONFEDERATES.

As marking an epoch not only in the growth of the torpedo and of its employment upon a large scale in actual warfare, but also as having led to great modifications in the art of shipbuilding as applied to war ships, and in view of the influence it exerted upon the conduct of the war, the means employed, and the results obtained by the Confederates seem to merit brief mention.

It is hard to place an estimate upon the value of torpedoes to the Confederate cause. In addition to their actual value as measured by the damage inflicted upon their adversary, the restraining influence exerted by these hidden devices upon the operations of the Federal fleet is hard to overestimate. Often were its blows timidly delivered, or rendered nugatory by the knowledge of their presence, which otherwise would have been driven home. The statement that their use by the South prolonged the war two years seems reasonable, for after the advent of the ironclad fleet, nothing else, it is believed, would have prevented its steaming up to the wharves of Charleston, or into any other Southern port. Booms and piling certainly would not have done so, for the fire of the fleet was sufficient to cover the removal of any ordinary obstructions.

The first recorded use of torpedoes by the Confederates was in July, 1861, against some Federal gunboats lying in the Potomac off Aquia Creek. These consisted of a cylinder of boiler-iron with a powder charge buoyed with an empty oil cask. A fuse led from the cask to the charge. A rope connected each pair of casks, intended to bring the machine up alongside the Yankee craft. The fuses were lit and a number of these were sent down on an ebb tide toward the gunboats. They were discovered, taken in charge by small boats, and the fuses extinguished before harm was done.

In October, 1862, a Torpedo Bureau was established in Richmond, with General Rains in charge, and a Naval Submarine Battery Service organized under Commander Hunter Davidson. An act of the Confederate Congress of that year provided that the inventor of any device by which a vessel of war should be destroyed should receive 50 per cent. of the value of vessel and armament. Torpedo stations were established at Richmond, Wilmington, Charleston, Savannah, and Mobile, and a special corps of operators organized.

The first Federal vessel destroyed was the ironclad gunboat *Cairo*, in the Yazoo River. A demijohn filled with powder, enclosed in a wooden box, and fired by use of a friction-primer, and a long lanyard leading to a pit on shore, were the means employed.

There is on record a list of 30 odd Federal vessels destroyed or seriously disabled by Confederate torpedoes. Of this number 24 were destroyed outright, of which 7 were ironclads and 7 transports. As to locality, 3 were in the Red and Yazoo rivers, 5 in the James, 7 in Charleston Harbor and vicinity, 4 in the St. John's (all transports), 3 in the waters of North Carolina, and 9 in Mobile Bay.

The destruction of the *Tecumseh* before Fort Morgan was accompanied with the most deplorable loss of life, as but 21 out of a crew of 141 escaped, while the blowing up of the *Commodore Jones*, in the James River, was perhaps the most dramatic incident connected with torpedo warfare. In the latter case a tank mine, containing, it is said, 400 lbs. of gunpowder, had been placed below Drury's Bluff, provided with electrical means of discharge. For some months an observer lay concealed in a sand-pit on shore waiting for the expected advance of the Federal gunboats. At last the looked for enemy appeared. The *Commodore Jones*, in advance, had just received orders to proceed to drag for torpedoes when she passed over the fatal spot. The explosion lifted her bodily from the water, her boilers exploded, and more than half her crew were killed, wounded, and drowned.

More than 90 per cent. of those used by the Confederates were mechanical contact mines, and proved dangerous to friend and foe alike, as the loss of several of their own vessels by their means testify. On the James River a number of electrical mines were planted, and in Charleston Harbor, during the general bombardment of April 7, 1863, the *New Ironsides* lay for an hour off Fort Wagner di-

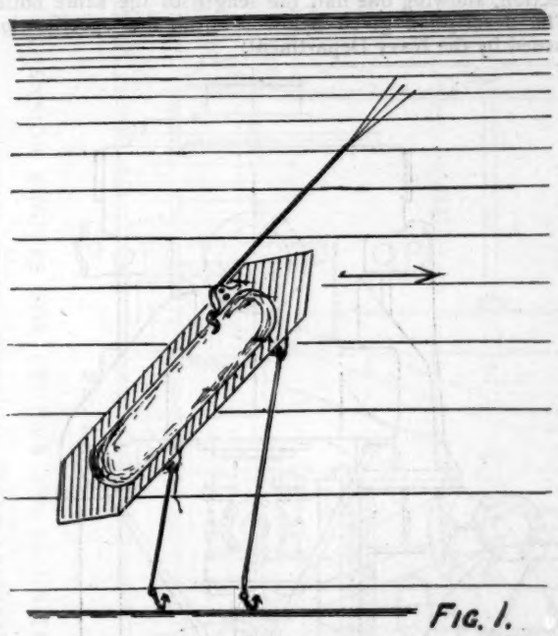


FIG. 1.

rectly over a 2,000-pound electrical boiler-iron mine. The operator tried in vain to discharge it. Treachery was suspected, but it was afterward discovered that an ordnance wagon on passing along the beach had severed the wires.

The spar torpedo was successfully used in a number of instances. The *Housatonic* was sunk at her anchorage in Charleston Harbor and the *New Ironsides* injured by spar torpedoes. The gallant manner in which Commander Cushing destroyed the Confederate ironclad *Albemarle* in Roanoke River, with a small torpedo launch, had its counterpart in the attempt of Commander Davidson to destroy the flagship *Minnesota*. Davidson, with a small steam torpedo boat, ran down the James from Drury's Bluff, 120 miles, to Hampton Roads, made his way among a crowd of vessels, and exploded a torpedo fairly against the side of the *Minnesota*. The blow was well delivered, but the small charge of 53 lbs. was not sufficient to break in her sides, although considerable damage was done.

In the beginning, torpedo material was, from necessity, very largely improvised. Casks, cans, demijohns, anything that would hold powder and keep out water were used, and some of the arrangements for firing the charges were of the crudest character. Later, better material and better service were secured. The fuses most generally used seem to have been the Jacobi sulphuric-acid fuse, and a very sensitive percussion fuse invented by General Rains, of which mention will be made hereafter.

Besides the common tin-can torpedo, which does not need special mention, there were a number of ingenious construction, some of which proved to be very efficient.

The pronged torpedo, shown in fig. 1, consisted of a hollow wooden or metallic case, anchored near the bottom,

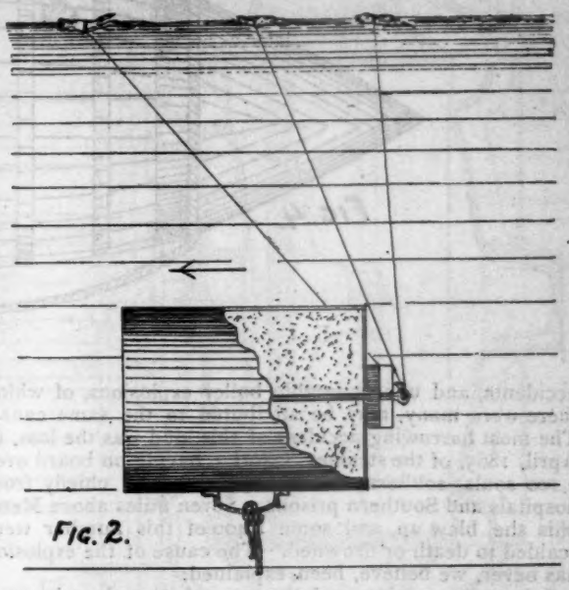


FIG. 2.

inside of which was a 70-pound charge of powder in a bag. A pronged rod projected from the upper side, pointing down stream, so that vessels going with the current could pass over it without harm. A blow upon the prong from the other direction would, however, release a trigger, explode a cap, and fire the charge.

The drifting torpedo of various forms was largely used. That shown in fig. 2 was as ingenious as any. It possessed considerable buoyancy and was weighted to a log of proper size to keep it a short distance below the surface. From one end projected a trigger-rod, at the inner end of which was a friction device for igniting the charge; at the other, three trigger lines, attached to small bits of driftwood, reached to the surface. The expectation was that these lines would become entangled in the screws or paddle-wheels of a passing vessel and thus explode the mine. The monitor *Osage* is reported to have been destroyed by a mine of this character.

The coal torpedo shown in fig. 3 had, externally, the appearance of an innocent lump of coal. In reality it was a

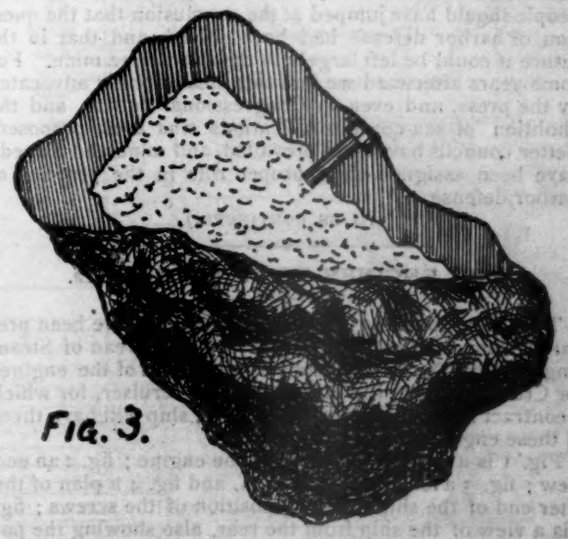


FIG. 3.

hollow block of cast-iron, covered with tar and coal dust, and containing, when charged, 10 lbs. of gunpowder. How much injury was inflicted by this kind of explosive is unknown. The transport *Greyhound* is reported to have

been destroyed in the James River, in November, 1864, by a coal torpedo, and very possibly some of the unexplained

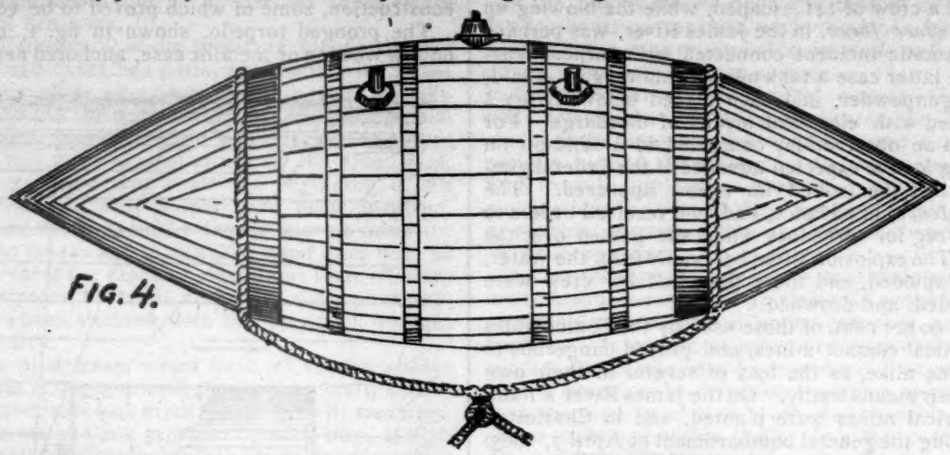


FIG. 4.

accidents, and unaccountable boiler explosions, of which there were many, may be attributed to the same cause. The most harrowing accident of this kind was the loss, in April, 1865, of the steamer *Sultana*, having on board over 2,100 souls, soldiers, and crew, the former chiefly from hospitals and Southern prisons. Seven miles above Memphis she blew up, and some 1,400 of this number were scalded to death or drowned. The cause of the explosion has never, we believe, been explained.

Submarine mining and the use of torpedoes in open warfare, are now recognized as perfectly legitimate by all civilized powers. But the use of such a device as a coal torpedo, against whose effects no provision can be made, and which may find its victims among non-combatants, passes beyond the limits of legal warfare and becomes barbarous, and is justly ranked with the poisoning of wells and the spreading of infectious diseases among a hostile people.

One of the most common forms of torpedo used in the South was the keg torpedo (fig. 4). Empty beer casks usually supplied the foundation, to which were added a cone of sheet iron at either end, and a number of projecting percussion fuses along the upper side. In the early days of torpedo construction an order is said to have been issued from Richmond confiscating all the beer kegs in the Confederacy for torpedo purposes.

With such havoc and destruction caused by mines and torpedoes on record at the close of the Civil War, and the practical introduction of high explosives soon after, it is not to be wondered at that even some professional military people should have jumped at the conclusion that the question of harbor defense had been solved, and that in the future it could be left largely to the submarine mine. For some years afterward we find this idea strongly advocated by the press, and even in Congressional debate, and the abolition of sea-coast fortifications was even proposed. Better councils have since prevailed, and mine and torpedo have been assigned their proper rôle in the problem of harbor defense.

(TO BE CONTINUED.)

THE ENGINES OF CRUISER No. 12.

THE accompanying illustrations, which have been prepared from drawings furnished by the Bureau of Steam Engineering, Navy Department, show one of the engines for Cruiser No. 12, the three-screw fast cruiser, for which a contract has recently been let. The ship will have three of these engines, one to each screw.

Fig. 1 is a general elevation of the engine; fig. 2 an end view; fig. 3 a longitudinal section, and fig. 4 a plan of the after end of the ship showing position of the screws; fig. 5 is a view of the ship from the rear, also showing the position of the screws; fig. 6 is a half cross-section showing position of the engine, and fig. 7 also a half cross-section showing position of the boilers in the ship. The engine for the middle screw is placed amidships and aft of the two engines for the outer screws, one of which is shown in fig. 6. Fig. 8 is half an end view and half a cross-section of one of the main boilers, and fig. 9 is a longitudinal section, showing one-half the length of the same boiler. The description given below is from the specifications issued by the Navy Department.

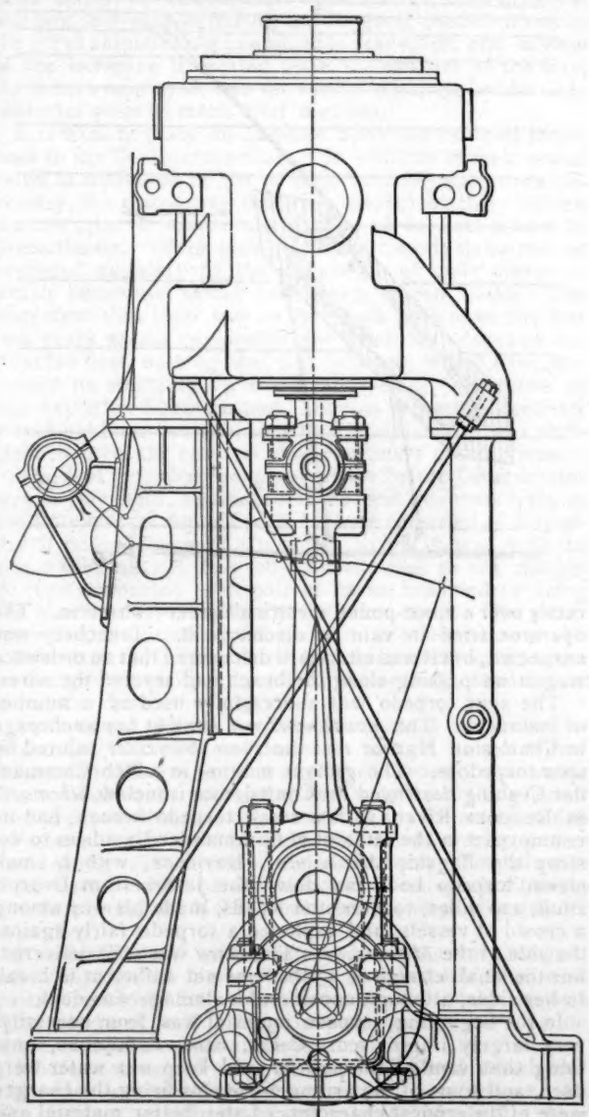


Fig. 2.

The engines are of the vertical, inverted-cylinder, direct-acting, triple-expansion type, each with a high-pressure

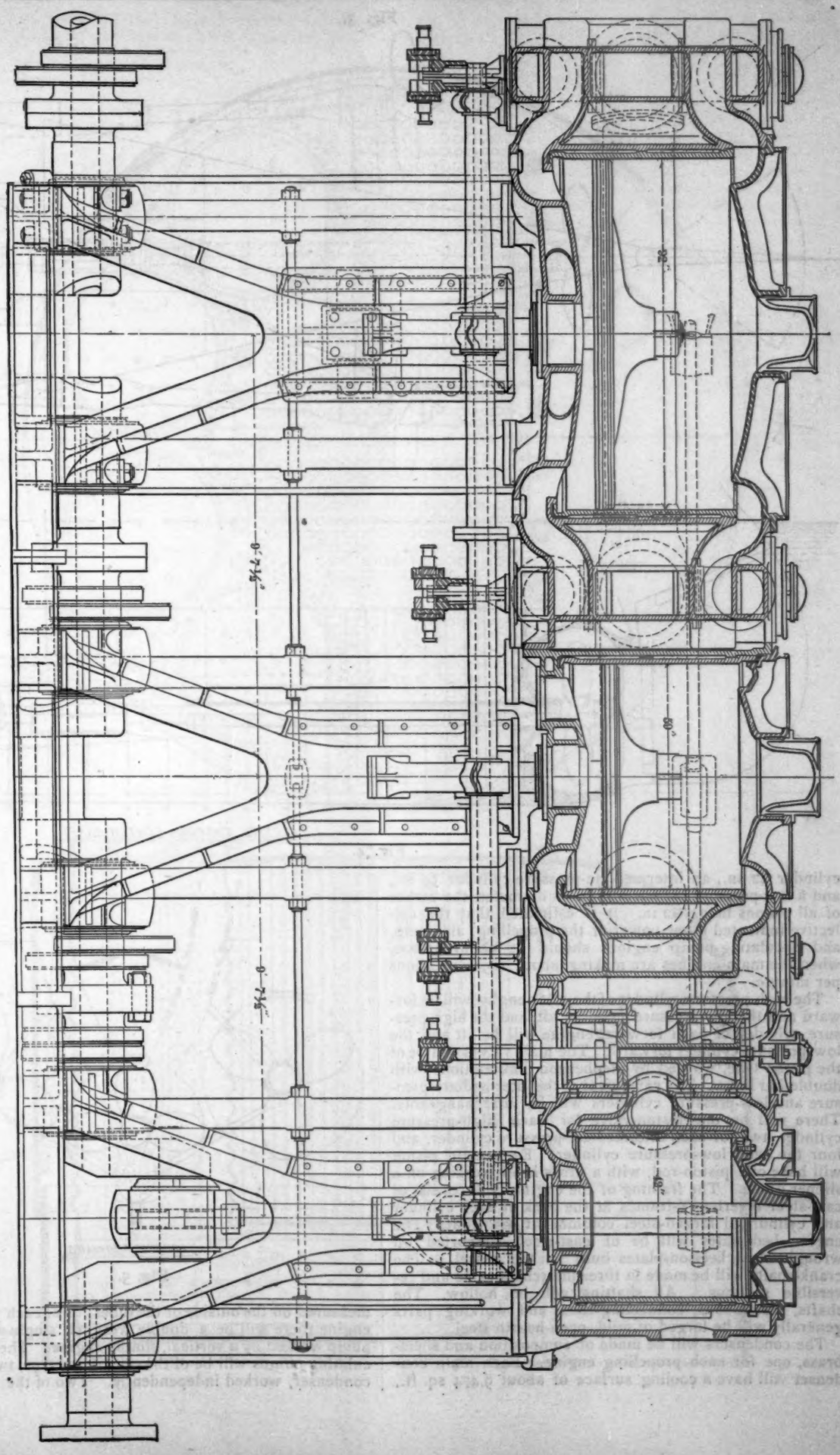
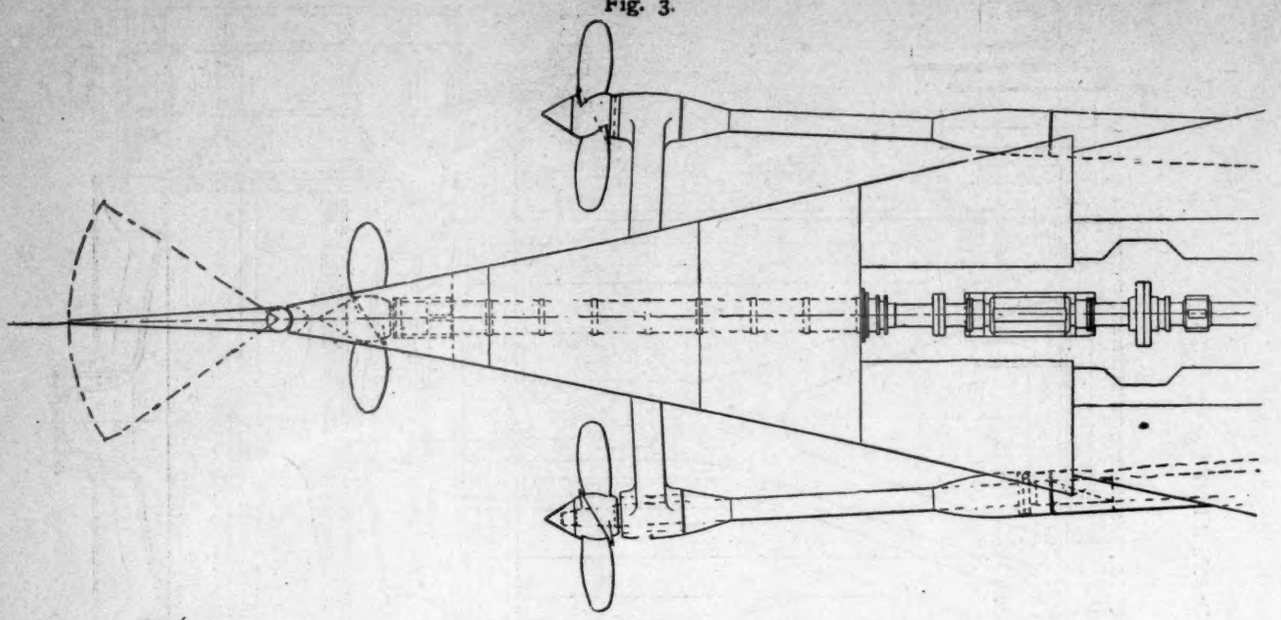


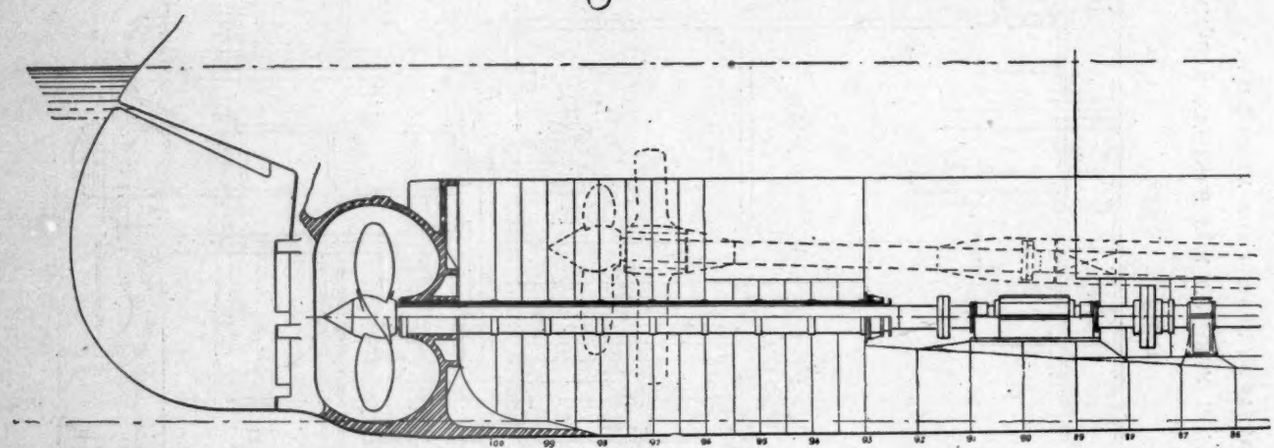
Fig. 1.

TRIPLE-EXPANSION ENGINES FOR CRUISER NO. 12, UNITED STATES NAVY.

DESIGNED BY THE BUREAU OF STEAM ENGINEERING.

Fig. 3.





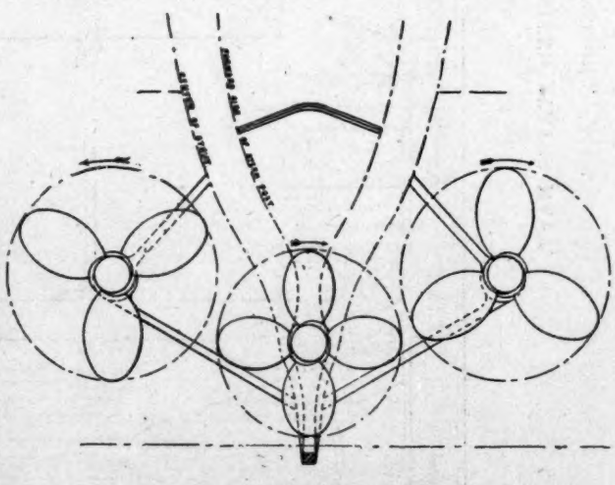
SECTION THROUGH CENTER SHAFT

Fig. 4.

cylinder 42 in., an intermediate-pressure cylinder 59 in., and a low-pressure cylinder 92 in. in diameter, the stroke of all pistons being 42 in. It is estimated that the collective indicated horse-power of the propelling, air-pump, and circulating-pump engines should be about 21,000, when the main engines are making about 129 revolutions per minute.

The high-pressure cylinder of the after engine will be forward and the low-pressure cylinder aft, and the high-pressure cylinder of each forward engine will be aft and the low-pressure cylinder forward. The main valves will be of the piston type, worked by Stephenson link-motions with double-bar links. The valve-gear of the intermediate-pressure and low-pressure cylinders will be interchangeable. There will be one piston-valve for each high-pressure cylinder, two for each intermediate-pressure cylinder, and four for each low-pressure cylinder. Each main piston will have one piston-rod, with a cross head working on a slipper-guide. The framing of the engines will consist of cast-steel inverted Y-frames at the back of each cylinder and cylindrical forged-steel columns at the front. The engine bed-plates will be of cast-steel, supported on wrought-steel keelson-plates built in the vessel. The crank-shafts will be made in three interchangeable and reversible sections. All shafting will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild, open-hearth steel.

The condensers will be made of composition and sheet-brass, one for each propelling engine. Each main condenser will have a cooling surface of about 9,474 sq. ft.,



LOOKING FORWARD

Fig. 5.

measured on the outside of the tubes. For each propelling engine there will be a double, vertical, single-acting air-pump worked by a vertical, simple engine. The main circulating pumps will be of the centrifugal type, two for each condenser, worked independently. Two of the propellers

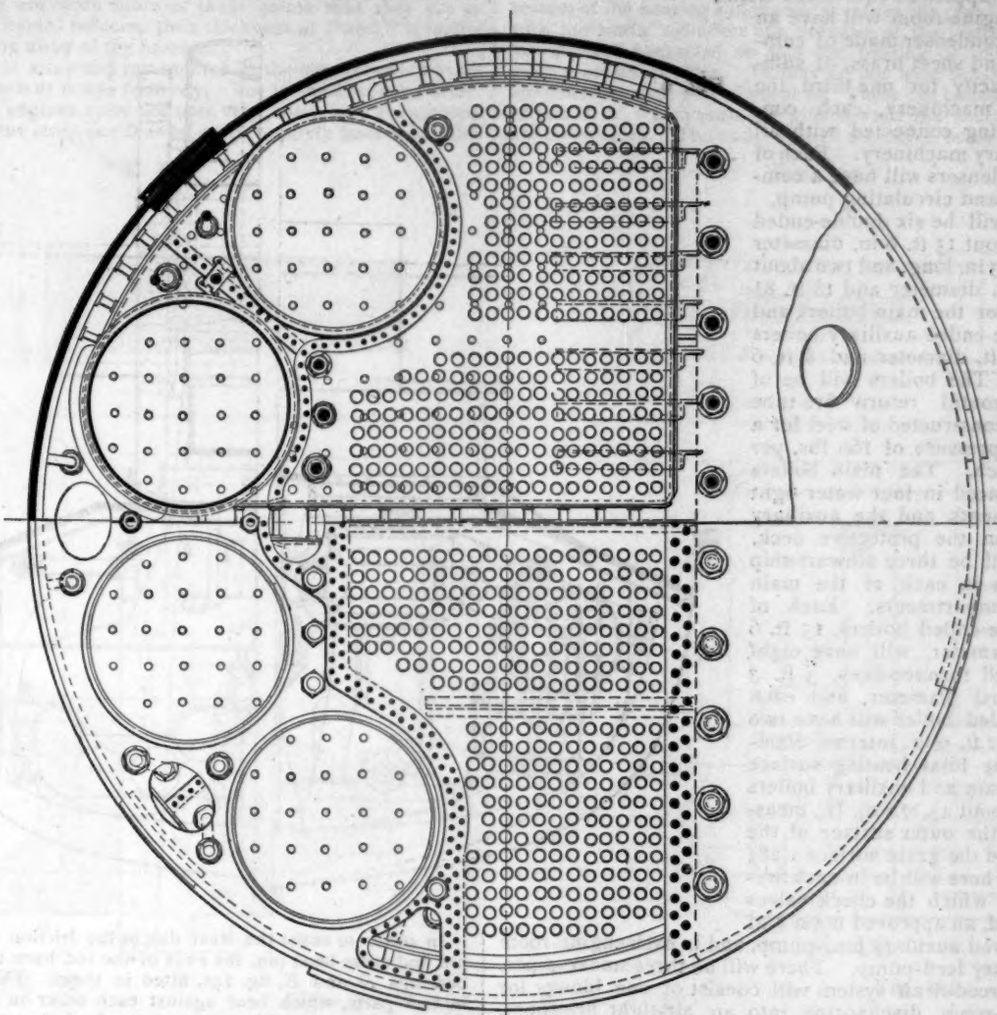


Fig. 8.

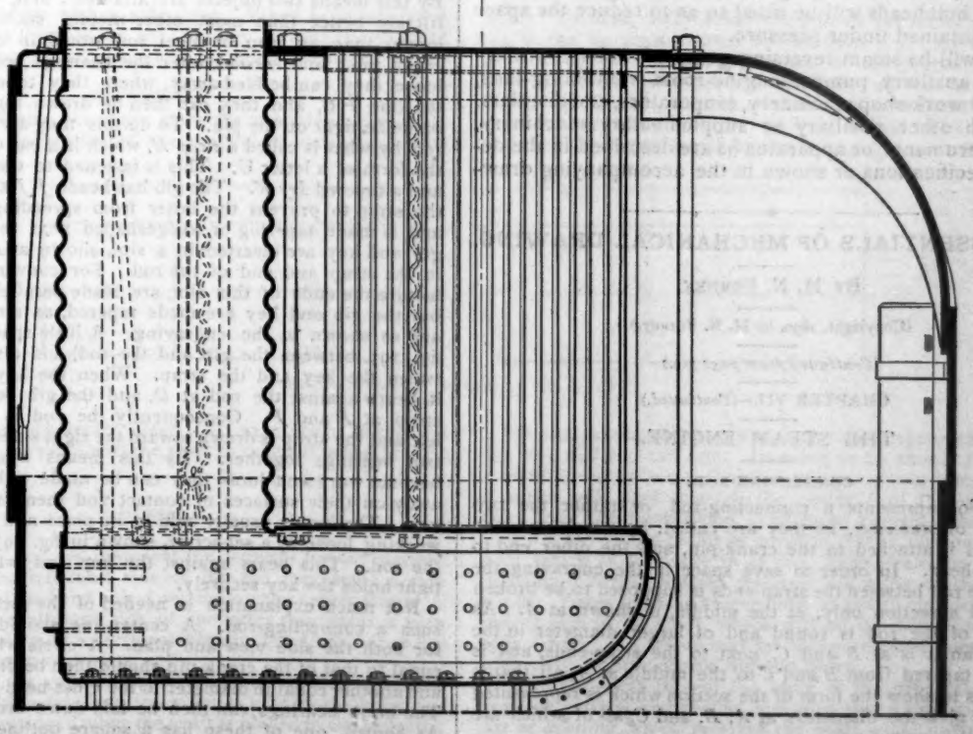


Fig. 9.

MAIN BOILER FOR CRUISER NO. 12, UNITED STATES NAVY.

will be right and one left, to be made of manganese bronze, or approved equivalent metal.

Each engine-room will have an auxiliary condenser made of composition and sheet brass, of sufficient capacity for one third the auxiliary machinery, each condenser being connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating pump.

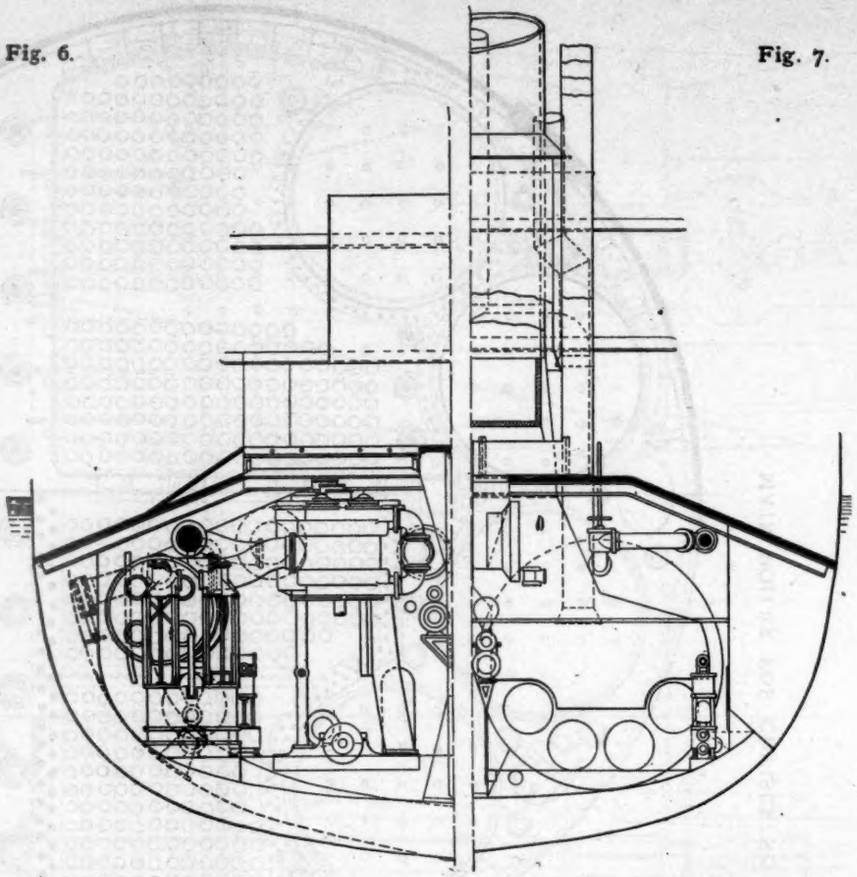
There will be six double-ended boilers about 15 ft. 6 in. diameter and 21 ft. 3 in. long, and two about 11 ft. 8 in. diameter and 18 ft. 8½ in. long for the main boilers and two single-ended auxiliary boilers about 10 ft. diameter and 8 ft. 6 in. long. The boilers will be of the horizontal return fire-tube type, all constructed of steel for a working pressure of 160 lbs. per square inch. The main boilers will be placed in four water-tight compartments, and the auxiliary boilers on the protective deck. There will be three athwart-ship fire rooms in each of the main boiler compartments. Each of the double-ended boilers, 15 ft. 6 in. in diameter, will have eight corrugated furnace-flues, 3 ft. 3 in. internal diameter, and each single-ended boiler will have two furnaces 2 ft. 9 in. internal diameter. The total heating surface for the main and auxiliary boilers will be about 43,272 sq. ft., measured on the outer surface of the tubes, and the grate surface 1,285 sq. ft. There will be in each fire-room, in which the check valves are placed, an approved main and an approved auxiliary feed-pump, and in each engine-room an auxiliary feed-pump. There will be three smoke-pipes.

The forced-draft system will consist of one blower for each fire-room, discharging into an air-tight fire-room. Air-tight bulkheads will be fitted so as to reduce the space to be maintained under pressure.

There will be steam reversing-gear, ash-hoists, turning-engines, auxiliary pumps, engine-room ventilating-fans, engine for work-shop machinery, evaporators, and distillers, and such other auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the detailed specifications or shown in the accompanying drawings.

Fig. 6.

Fig. 7.



THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

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(*Continued from page 519.*)

CHAPTER VII.—(*Continued.*)

THE STEAM ENGINE.

CONNECTING-ROD.

Fig. 189 represents a connecting-rod, or rather the two *strap-ends* or *stub-ends*, as they are called, by which one end of the rod is attached to the crank-pin, and the other end to the cross-head. In order to save space in the engraving the part of the rod between the strap-ends is supposed to be broken away, and a section only, at the middle, is shown at *A*. As this part of the rod is round and of larger diameter in the middle than it is at *B* and *C*, next to the strap-ends, and is regularly tapered from *B* and *C* to the middle at *A*, all that is required is to show the form of the section which is represented at *A* and give the diameters at *A*, *B*, and *C*, all of which are shown in the engraving.

External views of the one strap-end are shown at the right-hand side of the engraving, whereas at the other side the strap-end is shown in section in both the side view and plan.

In order to resist the wear due to the friction on the crank-pin and cross-head pin, the ends of the rod have brass journal-bearings *D* and *E*, fig. 195, fitted in them. These are made in two parts, which bear against each other on the line *F G*. By this means two objects are attained: first, as brass resists friction better than most other metals, such bearings wear longer than an iron or steel rod would in contact with the crank pin; and second, after the bearings become worn and loose they can be filed away, where they touch each other on the line *F G*, and they can then be drawn together and thus be made tight on the pin. To do this they are attached to the rod by what is called a *strap H*, which is a bar of iron bent into the form of a letter U. This is fastened to the rod by a gib *I* and a tapered *key K*. The gib has heads *J J* above and below the strap to prevent the latter from spreading or separating, and is made tapering or wedgeshaped next to the key. The gib and key are inserted in a slot, shown at *L*, fig. 193, made in the strap and end of the rod. For convenience in manufacture the ends of this slot are made parallel to each other, but the gib and key are made tapered, as already explained, and as shown in the engraving. A little space is left at *M*, fig. 195, between the gib and the rod, and also at *N N*, between the key and the strap. When the key is driven down it bears against the rod at *O*, and the gib bears against the strap at *P* and *P*. Consequently the rod is pushed to the left and the strap is drawn toward the right side which draws the two bearings together. By this means when the bearings become worn and loose they can be made tight by filing them away on their surfaces of contact and then driving down the key. The key is usually held in its place and prevented from working loose by a set-screw, shown in fig. 193, in the side of the rod. This bears against the key and when screwed up tight holds the key securely.

Not much explanation is needed of the method of drawing such a connecting-rod. A center-line should first be drawn for both the side view and plan. A circle whose diameter is equal to that of the crank-pin should then be drawn at one end, and another equal in diameter to the cross-head-pin at the other. The brass bearings can then be laid down around these pins. As shown, one of these has a square outline, and the other where it bears against the strap is octagonal. The bearings at

D and *E* are made thicker than at *F* and *G*, because at *D* and *E* they must resist the thrust and pull of the rod, and consequently they are worn more at these points than they are at *F* and *G*. Besides reducing their thickness at *F* and *G* it facilitates the filing away of the brasses.

The form of strap-end represented in the engraving is not as much used now as it was formerly. For locomotives and other fast-running engines bolts are now very commonly substituted for gibs, as the strap can thus be more securely fastened to the rod than is possible with a gib alone. When bolts are used for fastening the strap to the rod, the key is usually arranged so as to bear directly against one of the brass bearings.

Fig. 193.

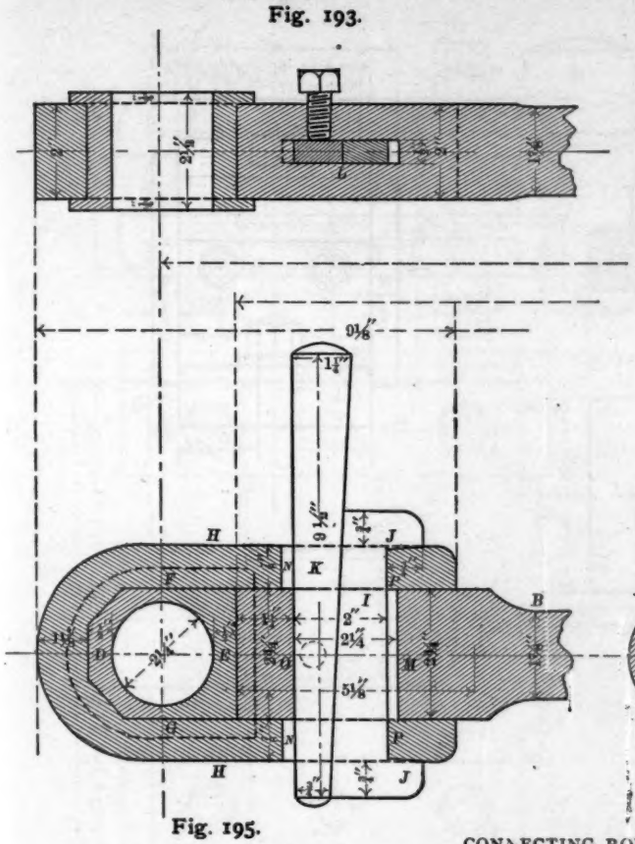


Fig. 194.

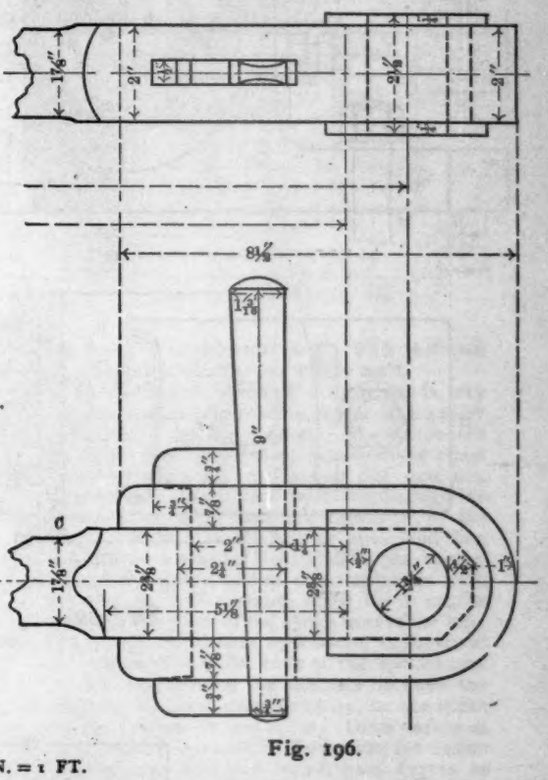


Fig. 195.

Fig. 196.

CONNECTING ROD. SCALE, 3 IN. = 1 FT.

MAIN SHAFT.

Fig. 197 represents the main shaft for a stationary engine. No explanation is needed of the method of drawing it, the engraving being sufficiently clear. To save space in the engraving, part of the middle of the shaft is represented as broken away.

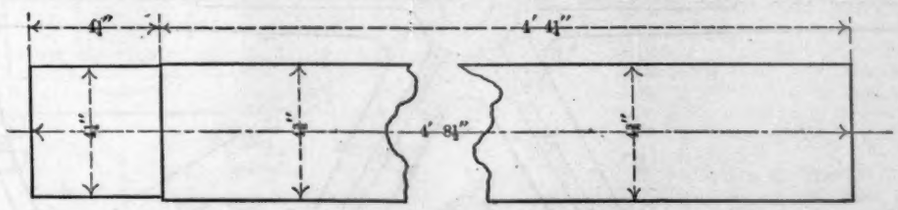


Fig. 197.

MAIN SHAFT. SCALE, 3 IN. = 1 FT.

PEDESTAL.

Figs. 198, 199, and 200 represent the pedestal for our stationary engine. The left-hand side of fig. 198 represents a side view, and the right-hand side a section on the center line *A B* of fig. 199. The left-hand side of the latter represents a plan and the right-hand side a sectional plan on the line *O D* of fig. 198. Fig. 196 is an end view.

As shown by the engravings, the pedestal consists of a cast-iron block *K*, with a cap *L* on top which is held by the bolts *I I*. This cap can be removed when the shaft is placed in the pedestal, and when the bearing is worn the cap can be filed away and drawn down by the bolts so as to "take up" the wear at the bottom of the bearing and the under side of the cap. In engines with horizontal cylinders the pressure of the piston is exerted forward and backward, so that the bearing of the pedestal is worn most on its sides. To take up this wear brass gibs *M M* are placed on each side of the shaft. These can be adjusted by set screws *N N*, which push the gibs toward the shaft when they are screwed up. The under side of the cap *L* bears on the gibs *M M*. By filing away either the gibs or the under side of the cap, it can be drawn down by the bolts *I I*. By this means the wear at the top and the bottom of the journal and at the sides can all be taken up, and the shaft can thus be kept sufficiently tight in the pedestal, so that it will not shake or pound, or have any "lost motion," as it is called. The pedestal is bolted to the engine frame by the bolts *J J*.

The student should draw the three views represented by figs. 198, 199, and 200 half size. In doing so he should first draw a horizontal center-line *C D* and a vertical center-line *E F*, both of which will pass through the center *O* of the main shaft. Then from the intersection *O* of these two lines as a center, draw a circle with a diameter equal to that of the journal of the shaft, which in this case in 4⅜ in. Then draw the horizontal base-line *G H* the required distance below the center *O*, which is 5 in. Draw vertical center-lines at equal distances from *O* and 7¾ and 16 in. apart, which will be the center-lines of the bolts *I I* and *J J*, which may be drawn on these lines after the other parts of the pedestal are laid down.

The width—10½ in.—of the body of the pedestal is laid off from the vertical center-line, and also the width—6 in.—of its jaw or opening which receives the shaft, gibs, and the projec-

Fig. 198.

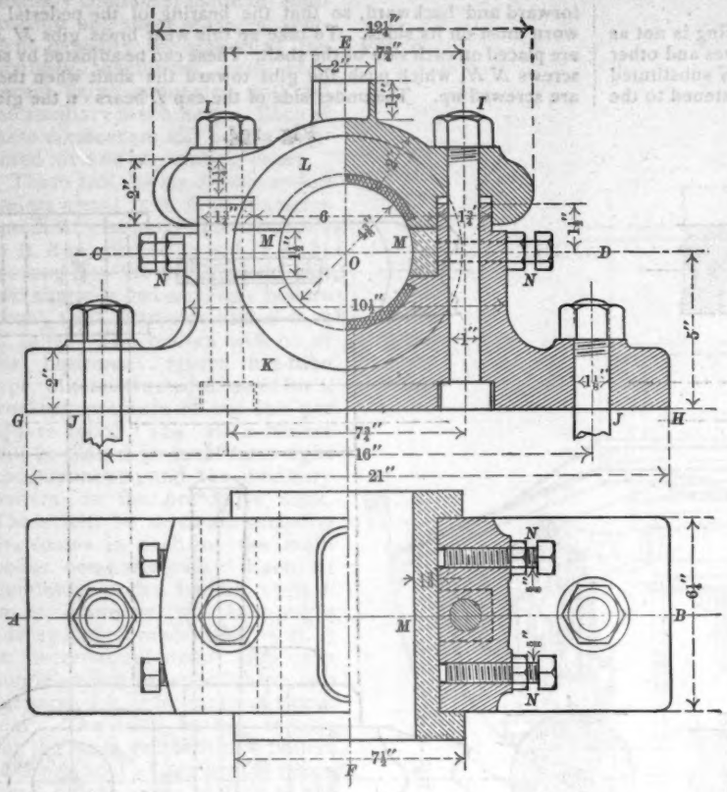
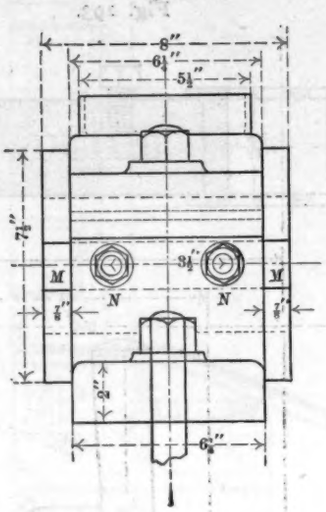


Fig. 199.

Fig. 200.



PEDESTAL. SCALE, 2 IN. = 1 FT.

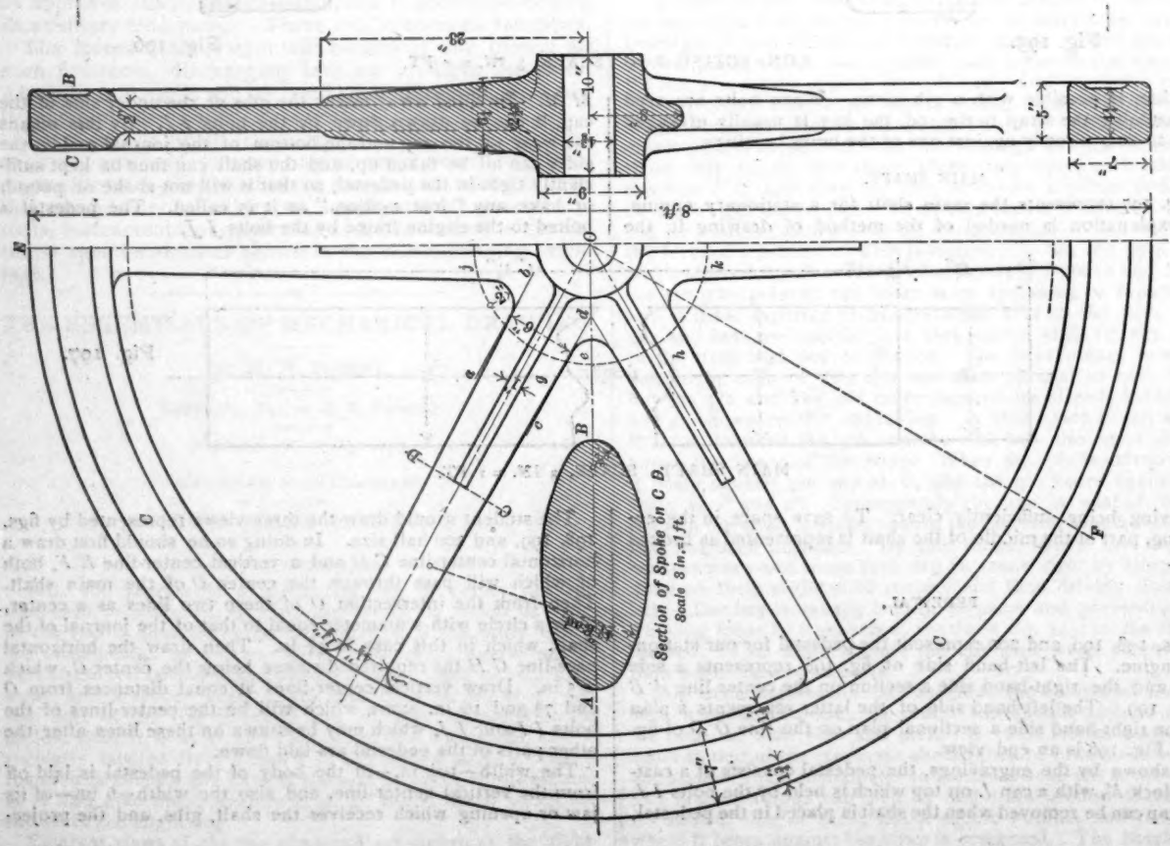


Fig. 202.

Fig. 201.

FLY WHEEL. SCALE, ¾ IN. = 1 FT.

tion on the lower side of the cap. The thickness of the cap above the shaft is readily laid down and its outline is drawn from the center *O*. The set-screws *N N* are drawn on the horizontal center-line *C D*, and in fig. 199 are laid off the proper distance apart, or, as shown in fig. 200, 3¼ in. measured from center to center. It will be noticed that each of these screws has a nut on it which bears against the pedestal. This is called a *lock-nut*, and its object is to clamp the screw and prevent it from unscrewing and thus allow the gibs to get loose. The inside of the cap and the bearing on the pedestal has a lining of Babbitt or other metal, which will resist wear better than cast-iron does. This lining is indicated in the section by cross-lines.

It will be seen that all of these views are drawn from one or more center-lines. These should be laid down first, and the student should work from them. The same method should be followed in drawing many of the subordinate parts, as the bolts and set-screws.

Fig. 203.

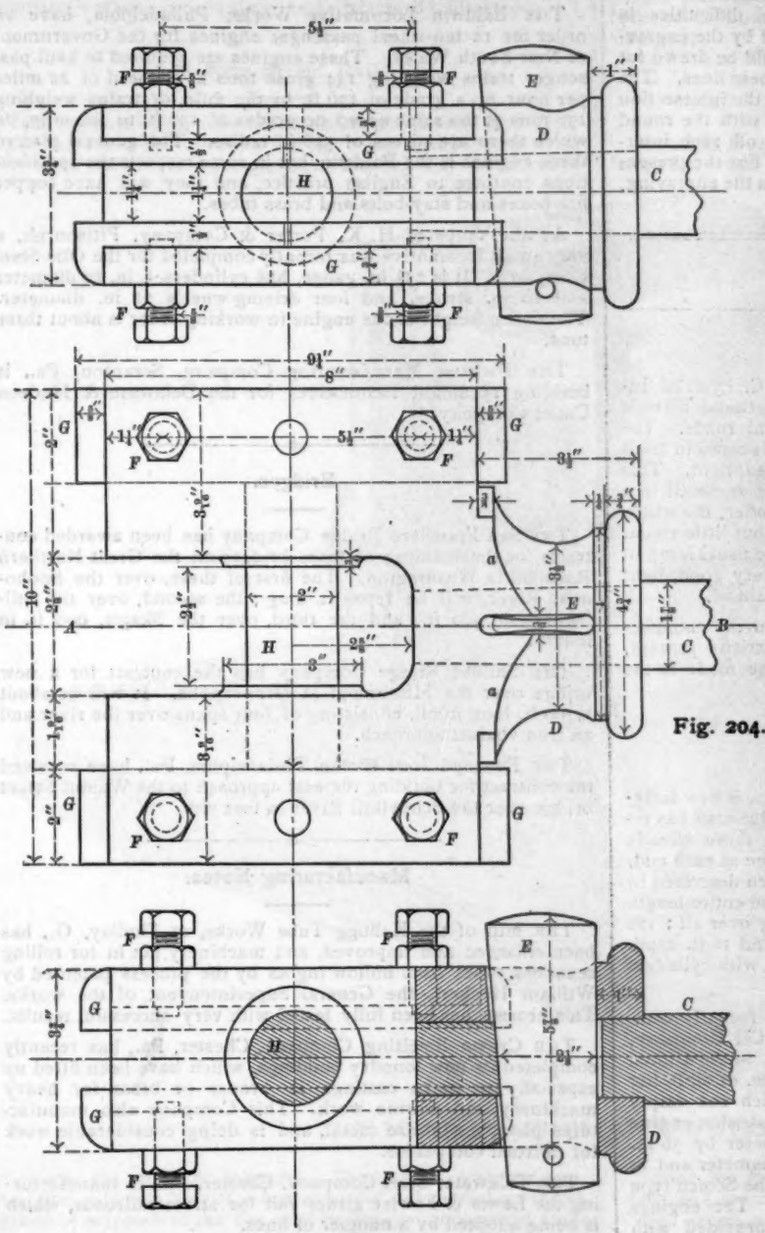


Fig. 205.

CROSS-HEAD. SCALE, 3 IN. = 1 FT.

FLY-WHEEL.

Fig. 201 represents a side view of one half of a fly-wheel. One half only of the wheel is shown, because the other half is exactly like it, and also to save space in the engraving and time in making the drawing. The student can draw the whole of the wheel if he is ambitious to produce a handsome pictorial effect. The drawing should be made to a scale of 1½ or 2 in. = 1 ft. Fig. 202 is a section on the line *E O F* of fig. 201. Fig. 202 is drawn on this irregular line in order to show a section of one of the spokes, and also the form of the hub and rim between the spokes. A section of one of the spokes on the line *C D* is shown at *A B*. This is drawn on a larger scale than the wheel itself.

Fig. 206.

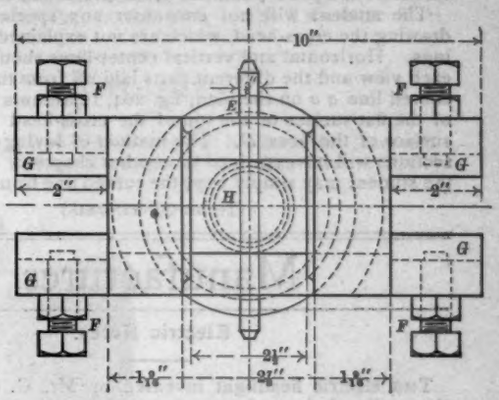


Fig. 204.

The method of drawing a fly-wheel is very similar to that employed to represent a pulley described in the last chapter. The rim should be drawn first and divided into as many equal parts as there are spokes—in this case six. Center-lines should then be drawn through the points of division and the center *O* of the wheel. Next draw the hub or nave, and then draw lines *a b* and *c d* parallel to the center-line of the spoke, and at equal distances from it, and let their distance apart be 6 in., or equal to the width of the spoke next to the hub. Then unite these lines by a curve, as shown at *e*. Repeat this at the ends of the spokes next to the rim, making the distance between the lines at this point equal to 4½ in., or the width of the spokes at that point. Draw curves as at *f*, uniting the parallel lines with the inside of the rim, and then unite these curves as *f* and *e* by a line *f e*, which will be the outline of the arm or spoke. Another method, which saves some work, is to lay off one of the curves at *f* and at *e* and then draw a circle, as *j e k*, or arcs of circles, as *l f*, which will pass through the centers of the curves *e* and *f*. Then lay off the width of the arms next to the hub, on the circle *j e k*, and that next to the rim on the arcs, as *l f*, and draw the outlines of the arms through the points thus laid off. The curves *f e* can then be added after the outlines of the arms have been drawn.

At *g* and *h* are ribs cast on the spokes to strengthen them next to the hub. The form of these ribs is shown in the upper part of the section, fig. 202.

The recesses or channels *G* and *H* are cast in the sides of the rim of the wheel to diminish the amount of surface to be turned off, and also to improve the appearance of the wheel. The spokes, it will be seen, are elliptical in shape, but are sometimes made rectangular or in the shape of a cross in section.

CROSS-HEAD.

Figs. 203 to 206 represent the *cross-head* of the engine whose parts are being illustrated in this chapter. As was recommended in other examples, the cross-head should be drawn either half or full size.

A *cross-head* is a sliding block attached to the end of the piston-rod to cause the latter to move in a straight line. Fig. 203 is a side view, fig. 204 a plan, fig. 205 a longitudinal section on the line *A B* of fig. 204, and fig. 206 is an end view looking at the left-hand end of fig. 203.

The piston-rod *C* is made to fit accurately in a conical hole in the boss *D*, and is held there by a tapered key *E*. A pair of brass gibs, *G G*, are attached to each side of the cross-head.

These slide on guides which are not shown in the engravings, and thus cause the cross-head to move in a straight line, which coincides with the center-line of the cylinder. The gibs are pressed down on the guides by set-screws *F F*, so that when the gibs wear they can be adjusted and kept tight on the guides. Each set-screw has a lock-nut which bears on the cross-head. The object of this is to hold the set-screw securely and prevent it from working loose. One end of the connecting-rod is attached to the pin *H*, and the other end to the crank.

The student will not encounter any special difficulties in drawing the cross-head, which are not explained by the engravings. Horizontal and vertical center-lines should be drawn for each view and the different parts laid off from these lines. The curved line *a a* on the plan, fig. 204, represents the intersection of the flat surface of the top of the cross-head with the round surface of the boss *D*. The method of laying off such intersections will be explained in another chapter. For the present the student may simply copy the curved line from the engraving.

(TO BE CONTINUED.)

Manufactures.

Electric Notes.

THE electric headlight invented by Mr. G. C. Pyle, of Indianapolis, Ind., and manufactured by the National Electric Headlight Company, has been tried on several roads. The arrangement adopted is the placing of a small dynamo in front of the smoke-stack and directly behind the headlight. This dynamo is run by a small four-cylinder engine enclosed in a case and receiving steam from the locomotive boiler, the whole arrangement being very compact and taking up but little room. An arc lamp is used which is substituted for the usual lamp in the headlight, and the results are said to be very good, light being thrown upon the track for a long distance ahead.

THE latest application of electric welding is in the manufacture of projectiles. Steel shells welded by electricity present, it is said, many points of superiority over those made in the ordinary manner.

Marine Engineering.

AT the yard of Neafie & Levy, in Philadelphia, a new ferry-boat for the New York, Lake Erie & Western Railroad has recently been launched. This boat differs from those already owned by the Company in having two screws, one at each end, like the ferry-boat *Bergen*, which has already been described in our columns. Like that boat, the shaft runs the entire length of the boat. The new ferry-boat is 215 ft. long over all; 188 ft. 3 in. long between stern posts; 45 ft. beam, and 16 ft. depth of hold. The engines are of the compound type, with cylinders 26 in. and 50 in. in diameter by 30 in. stroke.

THE Columbian Iron Works, Baltimore, have recently completed a steel tank steamer for the Standard Oil Company, which is the second steamer of this class built in the United States. The vessel has a capacity of 500,000 gals. of oil in her tanks, and is provided with Blake pumps which can empty these tanks in seven hours. She has a triple-expansion engine with cylinders 19 in., 30 in. and 50 in. in diameter by 36 in. stroke, operating a Hirsch propeller 11 ft. in diameter and 14 ft. pitch. Steam is supplied by two boilers of the Scotch type 12 ft. 9½ in. in diameter and 8 ft. 8 in. long. The engines have worked up to 1,300 H.P. The ship is provided with electric lights throughout.

Locomotives.

THE Kingston Locomotive Works, Kingston, Ont., are building five 10-wheel locomotives for the Canadian Pacific; 10 heavy mogul engines for the Grand Trunk, and four heavy tank locomotives for the Chignecto Ship Railroad in Nova Scotia.

THE Baldwin Locomotive Works, of Philadelphia, have a contract for 50 locomotives for the Great Northern Railroad, to be used on the Pacific extension of the line.

THE Richmond Locomotive Works, Richmond, Va., have recently received a contract for six passenger, three freight, and one shifting engine for the Louisville & Southern Road.

THE Western Locomotive Company has been incorporated with a capital of $2,500,000 for the purpose of building shops in Seattle, Wash., for the manufacture of locomotives. It is stated that the shops will be built at once.

THE shops of H. K. Porter & Company, in Pittsburgh, have just completed a Forney locomotive for the Milwaukee & White Fish Bay Railroad, a suburban line. The engine has 12 × 18 in. cylinders, and four drivers and weighs 23 tons ready for service. It is provided with the noiseless exhaust and Eames brake.

THE Baldwin Locomotive Works, Philadelphia, have an order for 12 ten-wheel passenger engines for the Government of New South Wales. These engines are required to haul passenger trains weighing 144 gross tons at a speed of 22 miles per hour up a grade of 176 ft. to the mile, or trains weighing 176 tons at the same speed up grades of 130 ft. to the mile, on which there are curves of 528 ft. radius. The general plan of these engines is the Baldwin, but in some respects the specifications conform to English practice, and they will have copper fire-boxes and stay-bolts and brass tubes.

AT the shops of H. K. Porter & Company, Pittsburgh, a very small locomotive was recently completed for the Otis Steel Company. It is 23½ in. gauge, has cylinders 5 in. in diameter and 10 in. stroke, and four driving-wheels 22 in. diameter. The entire weight of the engine in working order is about three tons.

THE Dickson Manufacturing Company, Scranton, Pa., is building 15 mogul locomotives for the Delaware & Hudson Canal Company.

Bridges.

THE San Francisco Bridge Company has been awarded contracts for the building of three bridges on the Great Northern Railroad in Washington. The first of these, over the Snohomish River, will be 1,700 ft. long; the second, over the Stillaguamish, 400 ft., and the third, over the Skagit, 600 ft. in length.

THE Shiffler Bridge Company has the contract for a new bridge over the Mississippi at Minneapolis. It will be about 1,700 ft. long in all, consisting of four spans over the river and an iron viaduct approach.

THE Pencoyd Iron Works, Philadelphia, Pa., have received the contract for building the east approach to the Walnut Street bridge over the Schuylkill River in that city.

Manufacturing Notes.

THE mill of the Kellogg Tube Works, at Findlay, O., has been enlarged and improved, and machinery put in for rolling seamless tubes from hollow ingots by the process patented by William Heckert, the General Superintendent of the works. This process has been fully tested with very successful results.

THE Crown Smelting Company, Chester, Pa., has recently completed its new foundry buildings, which have been fitted up especially to make castings in bronze or brass for heavy machinery and marine work. This Company also manufactures phosphor-bronze metal, and is doing considerable work for railroad companies.

THE Tidewater Steel Company, Chester, Pa., is manufacturing the Lewis & Fowler girder rail for street railroads, which is being adopted by a number of lines.

THE Lake Erie Engineering Works are building new shops in Buffalo, N. Y. These include a machine-shop 250 × 112 ft. and a foundry 230 × 112 ft. Both the machine-shop and foundry will be provided with 30-ton traveling cranes, by which work can be moved to any part of the shop.

Cars.

THE St. Charles Car Company, St. Charles, Mo., has recently completed two very handsome private cars, one for the Monterey & Mexican Gulf Railroad, and the other for the Rio Grande Western.

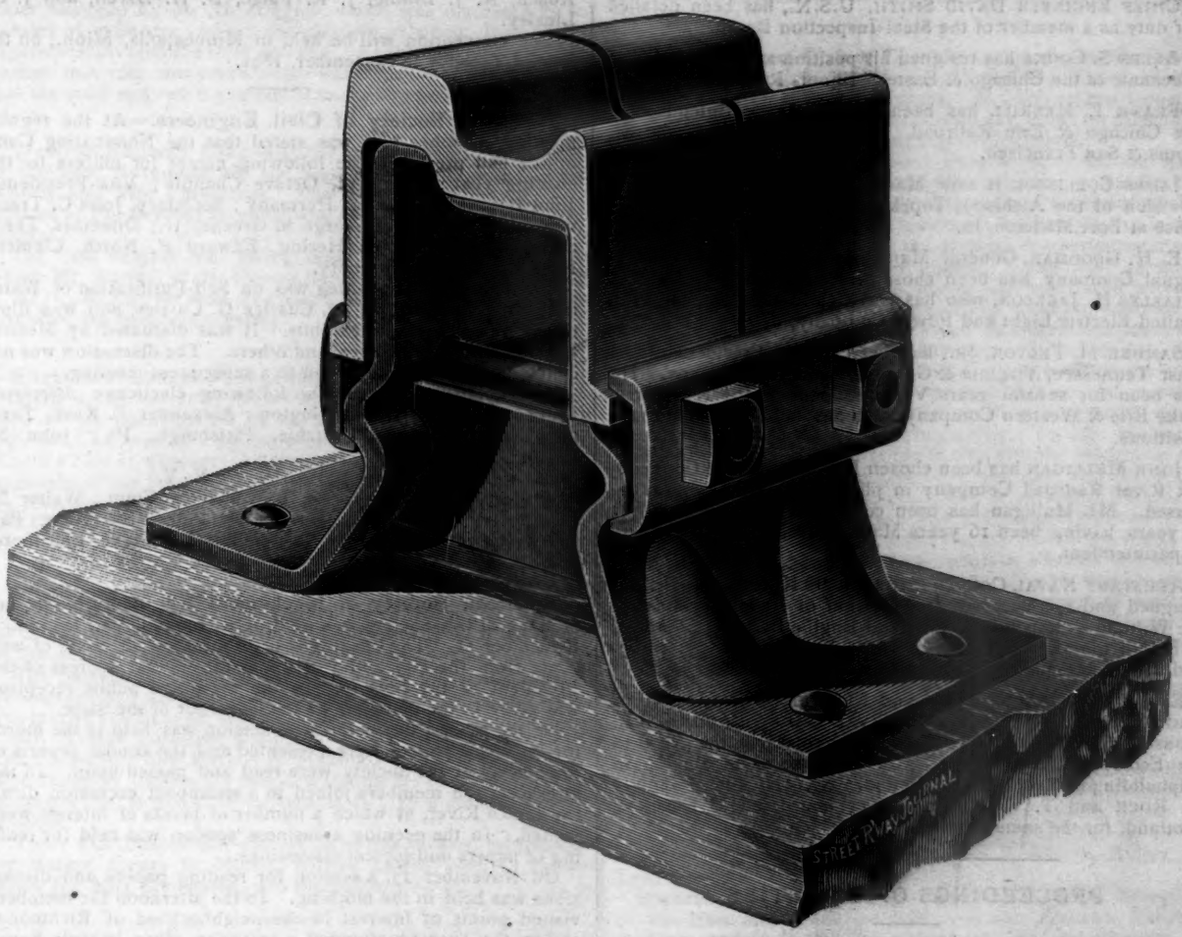
THE Scarritt Furniture Company, St. Louis, has the contract for Forney car-seats for a number of new cars which the New York, Lake Erie & Western Company is building for suburban travel.

THE shops of the United States Rolling Stock Company at Anniston, Ala., have recently turned out 100 box cars for the Cincinnati, New Orleans & Texas Pacific; 200 fruit cars for the Georgia Southern & Florida; 60 flat and 40 stock cars for the New Orleans & Northeastern.

IN accordance with the advice of a committee of creditors, a receiver has been appointed for the Harrisburg Car Manufacturing Company. Under his charge it is believed that the Company's affairs can, in time, be satisfactorily adjusted.

A New Street Rail.

THE accompanying illustration shows the Lewis & Fowler girder rail for street railroads, the cut being a perspective view of a joint, showing a cross-section of the rail and an end view of one of the chairs or supports. The general plan and construction, which is that of a box or girder rail carried on chairs spiked or screwed to the ties, will be readily understood from the engraving.



THE LEWIS & FOWLER GIRDER STREET RAIL.

The advantages claimed for this rail are proper distribution of metal to secure strength, and the fact that the joints and fastenings are so arranged that they will not loosen the first time there is a change in the atmosphere, provision being made by the spring of the rail flanges to take up all wear that may occur by contraction and expansion. The joints can be placed on chairs, or suspended between the ties, as preferred. The rail has no flanges or projections to interfere with the street pavement, and no holes are required in the web of the rail to weaken it. The head can be rolled of any shape desired, as well as of the form here shown. It is calculated that with six single chairs and one double (or joint) chair to a 30-ft. rail, the heaviest electric car can be carried with only very slight deflection.

The rails are rolled of steel, with the flanges projecting slightly outward, as well as downward, and when the fastenings are applied the flanges (or webs) are sprung into a vertical position. The bead at the bottom edge of the flange has an inclined top. The bead (or lip) on the clamp, which engages with the lip on the rail, draws the chair and rail firmly together, as the points of contact between rail and chair wear; the flanges of the rail being sprung in, naturally have a tendency to spring back to their normal positions, forcing the bead of the rail under the bead of the clamp, thereby holding the rail and chair firmly together.

These rails are being introduced by the Lewis & Fowler Girder Rail Company, of Brooklyn, N. Y. They are manufactured in Chester, Pa., at the mills of the Tidewater Steel Company.

OBITUARY.

ABRAM S. HULL, who died recently at his home in Chambersburg, Pa., was Master Mechanic of the Cumberland Valley Railroad for the long period of 34 years. He was born in 1826, and learned the machinist's trade in the Cumberland Valley shops, of which his father was Foreman. After seven years spent in various towns in the neighborhood, he again found employment in the railroad shops, and three years after this, in 1855, he was made Master Mechanic. A year ago he resigned, and was appointed to another position on the road. Mr. Hull was greatly respected and liked by all who knew him. He had much ability as a mechanic, and the faculty of imparting his knowledge to his subordinates.

SAMUEL ARCHBOLD, who died at his residence in Westover, Md., October 21, aged 74 years, was for many years a prominent naval architect. He entered the Navy in 1843 as assistant engineer and was gradually promoted, becoming Chief Engineer in 1859, after 16 years of continuous service, much of it at sea. He took part in the Mexican War and also in the Perry Expedition to Japan. In 1859 he resigned from the Navy and joined with Thomas Reaney in forming the firm of Reaney & Archbold, which established at Chester, Pa., what is now one of the largest ship-yards in the country. During the War a

great deal of work was done there for the Government. His business was carried on until 1871, when from various causes the firm failed, and the property afterward passed into the hands of the late John Roach. Mr. Archbold was then appointed Consulting Engineer for the Philadelphia & Reading Railroad Company, and under his supervision the Company's fleet of steel colliers was built, and also the repair shops at Port Richmond, which are now disused. In 1880 Mr. Archbold resigned and retired from active business, and since that time had lived in Maryland. His services were frequently called upon as Consulting Engineer, and he was a member of the Naval Advisory Board under Secretary Whitney, where his services were much appreciated.

PERSONALS.

CHIEF ENGINEER DAVID SMITH, U.S.N., has been detailed for duty as a member of the Steel Inspection Board.

ALLEN S. COOKE has resigned his position as General Master Mechanic of the Chicago & Eastern Illinois Railroads.

FRANK E. MERRILL has been appointed Superintendent of the Chicago & Erie Railroad. He was recently on the St. Louis & San Francisco.

JAMES COLLINSON is now Master Mechanic of the Chicago Division of the Atchison, Topeka & Santa Fé Railroad, with office at Fort Madison, Ia.

E. H. GOODMAN, General Manager of the Union Switch & Signal Company, has been chosen Vice-President in place of CHARLES H. JACKSON, who has resigned to take charge of the United Electric Light and Power Company, of New York.

SAMUEL M. FELTON, JR., has been chosen President of the East Tennessee, Virginia & Georgia Railroad Company. He has been for several years Vice-President of the New York, Lake Erie & Western Company, and has held other important positions.

JOHN MULLIGAN has been chosen President of the Connecticut River Railroad Company in place of N. A. Leonard, deceased. Mr. Mulligan has been connected with the road for 38 years, having been 16 years Master Mechanic and 22 years Superintendent.

ASSISTANT NAVAL CONSTRUCTOR LEWIS NIXON, U.S.N., has resigned and has accepted the position of Naval Architect of the William Cramp & Sons Ship and Engine Building Company in Philadelphia. Mr. Nixon has served 11 years in the Navy, and has done much good work as a designer.

ENSIGNS ROBERT STOCKER and ELLIOTT SNOW, ASSISTANT ENGINEER FRANK HIBBS and NAVAL CADET RICHMOND P. HOBSON, have been ordered by the Secretary of the Navy to the Ecole Maritime, at Paris, for a course of instruction in shipbuilding and Naval construction. NAVAL CADETS GEORGE H. ROCK and T. F. RUHM have been ordered to Glasgow, Scotland, for the same purpose.

PROCEEDINGS OF SOCIETIES.

American Institute of Architects.—The 24th annual convention was held in Washington, beginning October 22, and was a very successful meeting.

The following officers were chosen for the ensuing year: President, R. M. Hunt, New York. Vice-Presidents, W. W. Carlin, Buffalo, N. Y.; J W. McLaughlin, Cincinnati. Secretary, J. W. Root, Chicago. Treasurer, S. A. Treat, Chicago. Directors: L. T. Scofield, Cleveland, O.; W. M. Poindexter, Washington; G. M. Ferry, Milwaukee, Wis.; C. J. Clark, Louisville, Ky.; M. J. Dinmock, Richmond, Va.; Alfred Stone, Providence, R. I.; E. F. Fassett, Kansas City, Mo.; George C. Mason, Jr., Philadelphia.

Roadmasters' Association of America.—The Executive Committee makes the following announcement of the subjects on which reports are to be presented at the next yearly convention. The names of the committees are given with each subject:

1. *Frogs:* James Sloan, James Ryan, Timothy Hickey, P. Nolan, C. E. Jones, W H. Courtney, and J. A. Kerwin.

2. *New Joints:* B. Mertaugh, George E. Daggett, C. E. Marvin, J. A. Prentice, M. J. McInarna, J. H. Preston, and Alexander McGregor.

3. *Interlocking Devices and Position of Guard-rail at Derailing Switches:* R. Black, W. H. Stearns, J. Wynn, C. N. Comerford, J. H. K. Burgwyn, J. W. Offutt, and G. M. Brown.

4. *Track Jacks:* J. M. Meade, J. D. Mandeville, F. C. Clark, F. X. Garlarneau, M. Shea, N. A. Freeland, and D. P. Beatty.

5. *Best General Methods of Doing Track Work upon the Different Kinds of Ballast:* O. F. Jordan, C. H. Cornell, J. E. Dorsey, J. C. Ryan, S. H. Brown, H. D. Hanover, and J. B. Gilchrist.

6. *What is Considered to be the Best Proportion of Chemicals Found in the Steel Used in the Manufacture of Rails; also Weight and Section of Rails Necessary to Secure the Best Results:* R. Caffrey, William Riley, J. E. Cox, P. H. Loftus, William Wright, C. Buhrer, and James Schofield.

7. *Which Mode of Laying Rails will Give the Better Results, Broken or Even Joints?* John Sloan, James Bolan, P. K. Roach, A. J. Diddle, J. R. Patch, D. H. Lovell, and J. H. Linsley.

The convention will be held in Minneapolis, Minn., on the second Tuesday in September, 1891.

American Society of Civil Engineers.—At the regular meeting, October 5, it was stated that the Nominating Committee had presented the following names for officers for the ensuing year: President, Octave Chanute; Vice-Presidents, John Bogart and Charles Hermany; Secretary, John C. Trautwine, Jr.; Treasurer, George S. Greene, Jr.; Directors, Theodore Cooper, Rudolph Hering, Edward P. North, Clemens Herschel, and S. Whinnery.

The paper of the evening was on Self-Purification of Water in flowing Streams, by Dr. Charles G. Currier, and was illustrated by microscopic exhibits. It was discussed by Messrs. Brush, Harris, Washburn, and others. The discussion was not concluded, but was continued to a subsequent meeting.

The tellers announced the following elections: *Members:* Francis R. Fava, Jr., Washington; Alexander E. Kastl, Tampico, Mexico; James Ritchie, Pittsburgh, Pa.; John N. Ostrom, New York.

Associate: Henry S. Jacoby, Ithaca, N. Y.

Juniors: Henry L. Davis, New Haven, Conn.; Walter D. Dusenberry, New York; George H. Paine, Swissvale, Pa.; Lee Treadwell, Sioux City, Ia.; Arthur L. Shreve, Baltimore, Md.

American Society of Mechanical Engineers.—The fall meeting of this Society was held in Richmond, Va., beginning November 11. The opening session included addresses of welcome from the city authorities and the annual address of the President of the Society. In the evening a public reception was given to the members by the Governor of the State.

On the second day a business session was held in the morning, at which papers were presented and the annual reports of the officers of the Society were read and passed upon. In the afternoon the members joined in a steamboat excursion down the James River, at which a number of points of interest were visited. In the evening a business session was held for reading of papers and topical discussions.

On November 13, a session for reading papers and discussions was held in the morning. In the afternoon the members visited points of interest in the neighborhood of Richmond, and in the evening attended a reception given in their honor by the citizens of Richmond.

Friday, November 14, was devoted to an excursion by special train and boat to Newport News and Norfolk, where the members visited the new shipyards at Newport News, docks at that place, points of interest at Old Point Comfort and vicinity, the Navy Yard, and other establishments at Norfolk. From that point most of the members returned directly home.

Master Car-Builders' Association.—The Committee on Joint Inspection at Interchange Points has issued a circular, requesting information from members as to the present practice in relation to joint inspectors, the results obtained and the methods adopted to enforce the rules of interchange and to secure uniformity in inspection. Answers to this circular are to be sent to the Chairman of the Committee, Mr. A. M. Waitt, of the Lake Shore & Michigan Southern, at Cleveland, O.

New York Railroad Club.—An adjourned meeting of this Club was held at the new rooms in the Gilsey House, New York, November 20, at which a new constitution and by-laws were presented and adopted, and the club organized for the ensuing season. The following officers were chosen for the en-

suing year: President, Ross Kells; Vice-Presidents, R. C. Blackall, W. L. Hoffecker and Frank S. Gannon; Secretary, H. G. Prout; Treasurer, C. A. Smith; Executive Committee, John S. Lentz, Wm. Buchanan, W. H. Lewis, H. S. Hayward. Thomas Aldcorn; Finance Committee. E. S. Andress, J. H. Bailey, S. W. McMunn.

The removal of the meeting-room and the holding of meetings in the daytime were intended to suit the convenience of the many visiting railroad men who were unable to attend under the old conditions.

Northwest Railroad Club.—At the regular meeting in St. Paul, Minn., November 8, the first subject for discussion was Rigid and Swing-Beam Trucks, which was opened by a paper by Mr. J. C. Barber. On account of lack of time the discussion was not completed, but was continued until the next meeting.

The other subject was Locomotive Side-Rods, on which a paper was read by Mr. H. Higgins, which was discussed by a number of members present, the majority of whom, from their experience, favored the solid end rod. At the conclusion of the discussion a vote was taken which was in favor of the opinion that the solid-end rod is preferable to the strap-rod.

Western Railway Club.—At the regular monthly meeting in Chicago, November 18, the first subject was Steel-Tired Wheels and Tire Fastenings. The paper presented by Mr. Rhodes at the October meeting was discussed at considerable length.

The next subject was Swing-Beam and Rigid Trucks, on which Mr. Durrell, of the Illinois Central, presented some data.

Mr. C. A. Shroyer read a paper on Draft Rigging, which was discussed by members present.

Engineers' Club of Philadelphia.—At the regular meeting, October 4, the Secretary presented a correspondence with regard to the participation by the Club in the proposed International Congress of Engineers to be held during the coming World's Fair at Chicago, and moved that a committee of three, to consist of the President and two other members to be named by him, should be appointed to take up this subject so far as this Club is concerned. It was so ordered.

AT the regular meeting, October 18, with reference to the International Congress of Engineers, the President stated that he had appointed Messrs. Wilfred Lewis and E. V. d'Invilliers as the members of the committee referred to.

The Secretary presented, for Mr. Robert A. Cummings, a photograph and description illustrating the effect of gases from locomotive stacks upon vegetation.

Mr. Arthur Falkenau presented an extensively illustrated description of a new Method of Making Barrels by Machinery. The drawings illustrating this description are of so elaborate a character that it would be impossible to give a comprehensive abstract.

There was considerable discussion of this subject, principally by Messrs. Henry G. Morris, Wilfred Lewis, John C. Trautwine, Jr., Max Livingston, and the author.

AT the regular meeting, November 1, the Committee representing the Club in relation to the proposed Congress of Engineers in Chicago made a report, with the recommendation that the Club should agree to meet its share of the expenses, the necessary amount to be raised by subscription.

Mr. Benjamin Franklin presented a paper upon the Application of Drain Tiling to the Improvement of Ground for Residences.

There was some discussion of this paper. Mr. Howard Murphy noted a case where drain tiling had been used by him around a private residence in order to relieve the flooding and dampness in the cellar.

The Secretary presented, for Mr. Harvey Linton, a paper upon Topographical Surveying, with photographic illustrations.

Engineers' Society of Western Pennsylvania.—The regular meeting, October 21, was the first held by the Society in its new quarters in the Thaw Mansion. W. J. McFarland, James Foster, George H. Hodginson, and Charles F. Wieland were elected members. Thanks were voted to several visiting members of the Iron & Steel Institute for drawings, specimens, etc., presented.

Professor John W. Langley read a paper on European Bessemer Practice in Small Converters, giving his observations made during a trip abroad.

Engineers' Club of Cincinnati.—At the regular November meeting, the Secretary announced the death of Charles L. Jungerman, a member, and a committee was appointed to prepare suitable resolutions.

Mr. J. C. Lemon read a very interesting paper on Cast Iron Water Pipes, which was discussed by members present.

Engineering Association of the Southwest.—The annual meeting was held in Nashville, Tenn., November 13, when reports were presented showing that the Association was in good condition, and had made excellent progress during its first year. A number of candidates were elected to membership, and an address was made by the President, Colonel John McLeod.

Civil Engineers' Club of Cleveland.—At the regular meeting, November 11, James Wallace Kelly and Frank Walter Wilson were elected active members. Mr. Eisenmann reported the action of the committee at Chicago appointed to formulate a plan for an International Congress of Engineers.

Professor Harry Fielding Reid gave a paper on the Muir Glacier. Dr. Reid conducted an exploring party to Alaska this last summer, and he gave a very interesting description of this glacier, which covers an area of 1,000 square miles, flowing in two opposite directions, and having two termini, one at tidewater and the other several hundred feet higher. The lower, 1¼ miles wide, terminus is about 250 ft. above the water, and extends an unknown depth into the water, which has been sounded to the depth of about 1,000 ft. From this terminus immense masses of ice are continually breaking off, falling into the water and floating away as icebergs. One most remarkable phenomenon was observed, the existence of a central moraine extending from end to end, moving in two opposite directions and apparently having no beginning. Its like has never before been observed. After much difficulty the velocity at the lower end was found to be 8 or 10 ft. per day, and the upper end probably between 2 and 3 ft. The belief is that the glacier is receding, and to determine this permanent stations have been established from which observations will in the future be made, and other means taken to ascertain whether or not one part is not what is called a dead glacier. The ice was observed to have different colors, depending on the amount of sunlight it had been exposed to. The glacier has several lateral branches with different names, one of which is the White Glacier from the whiteness of its ice.

At the conclusion there was an interesting discussion of a number of the remarkable phenomena observed.

Western Society of Engineers.—At the regular meeting, October 1, the following members were elected: Charles E. Hopkins, Charles V. Weston, Theodore Starrett, Jacob A. Harman, Henry E. Gamble, Ira Smith Dunning, L. C. B. Holmboe, Charles J. Morse, William E. Miller, Ridley H. Lawrence, Harold A. Boedker.

Reports were received from the committees on Reception of the Iron and Steel Institute; on the Chicago Railroad Problem, and on Bridge Legislation, all reporting progress.

Mr. Isham Randolph read an interesting paper on Railroad Signaling and Interlocking, which was discussed at length by members present. Mr. Hausel, Consulting Engineer of the Illinois Railroad Commission, made some interesting statements as to the measures taken by that Commission to require improved signals at grade crossings, and stating the progress which had been made in that direction.

Montana Society of Civil Engineers.—At the regular monthly meeting in Helena, Mont., on October 18, correspondence with the Western Society of Engineers in relation to an International Congress of Engineers, to meet in Chicago during the World's Fair, was submitted. Correspondence with the Engineers Club of St. Louis and a letter of thanks from Honorable T. H. Carter were also submitted. Amendments to the articles of association of engineering societies previously submitted were approved.

It was resolved that a committee of three be appointed to frame a bill for the protection of life from open mine shafts and prospect holes, and to present the same to the Montana Legislature at its next session. Messrs. Keerl, Hovey, and McRae were appointed such committee.

NOTES AND NEWS.

Worshiping the Locomotive.—In a foot-note to an article by Mr. Gladstone on Mr. Carnegie's "Gospel of Wealth," published in a recent number of the *Nineteenth Century*, in London, in speaking of objects of worship the distinguished author says: "I understand that in some remote districts of India, where school-training has not penetrated, the locomotive has been seen to receive offerings of cocoanuts and flowers."

Railroads Needed in Africa.—To make the great system of inland waterways easily accessible to commercial exploitation from without would require a system of railroads aggregating, perhaps, 2,000 miles in length. The chief lines would be around the Livingstone Cataracts, on the Congo, from Vivi to Stanley Pool; a line from the coast to the Upper Niger; the long talked-of line from Suakim to Berber, and a line 500 miles long from Mombasa to the Victoria Nyanza. These four lines would absorb about 1,400 miles of the 2,000 estimate. Minor lines would connect Lakes Nyassa and Tanganyika, take the place of the Stewart Road around the Murchison Cataracts, on the Shirè, and overcome the difficulties at such points as Stanley Falls, and the cataracts of the Upper Nile system. A length of 40 miles would be required on the Shirè, a dozen miles at Lahore, and at various points lengths of railroad varying from near 200 miles between Nyassa and Tanganyika to a couple of miles around some of the lesser cataracts. The estimated cost of this comprehensive system of small, isolated railroads is, roughly, $50,000,000.—*Thomas Stevens, in Scribner's Magazine for September.*

The Pike's Peak Railroad.—This line, from Manitou, Col., to the summit of Pike's Peak, is a rack-railroad on the Abt plan, which has been heretofore described in our columns. Its length is 46,158 ft., or 8.74 miles. The altitude of its station at Manitou is 6,600 ft.; at the summit it is 14,200 ft. above sea-level, the total ascent being 7,600 ft., or an average of 846 ft. per mile. The maximum grade is 25 per cent., over 22 per cent. of the line having a grade of from 22½ to 25 per cent. Of straight line there is 28,378 ft., and of curved 18,477 ft., about 39 per cent. of the line being on curves. The sharpest curves are 16°, of which there are many. The road-bed foundations are firmly secured, and further protected and sustained by wide embankments wherever practicable. There are four iron bridges—two of 20 ft. and two of 30 ft. span, resting on masonry abutments

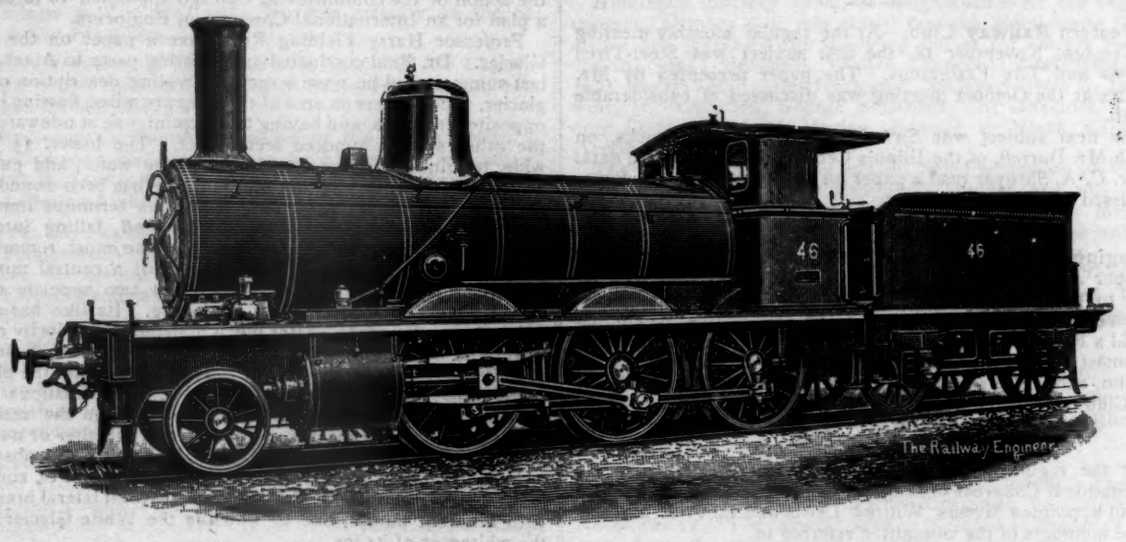
The three locomotives, which were built at the Baldwin Works, in Philadelphia, weigh 25 tons each. They are carried on six bearing-wheels, and there are two driving-wheels engaging with the rack-rail. The cylinders act upon a drum placed directly over the rear driver, and the forward driver is connected by parallel rods.

The brake apparatus is especially powerful. On either side of the pinions is a corrugated surface against which a steam-brake presses with great force. The engine is also fitted with hand-brakes and the Le Chatelier water-brake, by which the cylinders act as brakes. One engine will push two cars weighing 42,000 lbs. loaded. The average speed will be five miles an hour. The cars are not tilted, but the seats are so arranged as to give the passengers a level footing. The engine, instead of drawing, pushes the cars. The cars can also be let down hill independent of the engine, if necessary.

A Railroad Church.—Bishop W. D. Walker, of the Episcopal Church in North Dakota, has had a special car fitted up as a traveling church, in which he makes his visitations through his extensive diocese. The car goes from point to point, is run on a siding wherever the Bishop means to stop, and is used at all the points—still numerous—where there are no regular houses of worship. It is fitted up neatly inside, and will hold a congregation of some size.

The idea may be original with Bishop Walker, but the Russians used it a year or two ago, and have a traveling church and also a traveling school-house, which visit periodically the way stations on the Trans-Caspian Railroad.

A Swiss Compound Locomotive.—The accompanying illustration, from the *Railway Engineer*, shows a compound locomotive built by the Société Suisse at Winterthur for the Jura-Berne-Lucerne Railroad. The engine is on the Von Borries system, with one high-pressure and one low-pressure cylinder. The cylinders are outside, and have the steam-chests on top, the valve motion, which is an ordinary link motion, being in-



side; the valves are worked from a rocker shaft, in a manner similar to that generally in use in this country.

The high-pressure cylinder is 16.7 in. and the low-pressure 25.2 in. in diameter, both being 25.6 in. stroke. The grate area is 16.15 sq. ft.; the heating surface is: Fire-box, 80.7; tubes, 1,223.9; total, 1,304.6 sq. ft. The driving wheels are 59.8 in. in diameter; the leading and trailing wheels are 36.6 in., and the leading axle is carried in radial axle boxes.

The engine weighs 94,800 lbs. in working order. The tender carries 1,570 gallons of water and 9,250 lbs. coal, and weighs 46,300 lbs. when fully loaded.

The volumes of the two cylinders have a ratio of about 1 to 2. The valve motion is arranged so as to equalize as much as possible the work done by the steam in the two cylinders. In the Von Borries' system this end is attained by giving different lengths to the levers from which the links are hung. In the engine in question the degrees for admission in the two cylinders when in forward gear are:

High-pressure, 13, 20, 31, 41, 51, 60 and 76 per cent.

Low-pressure, 20, 29, 42, 51, 59, 66 and 80 per cent.

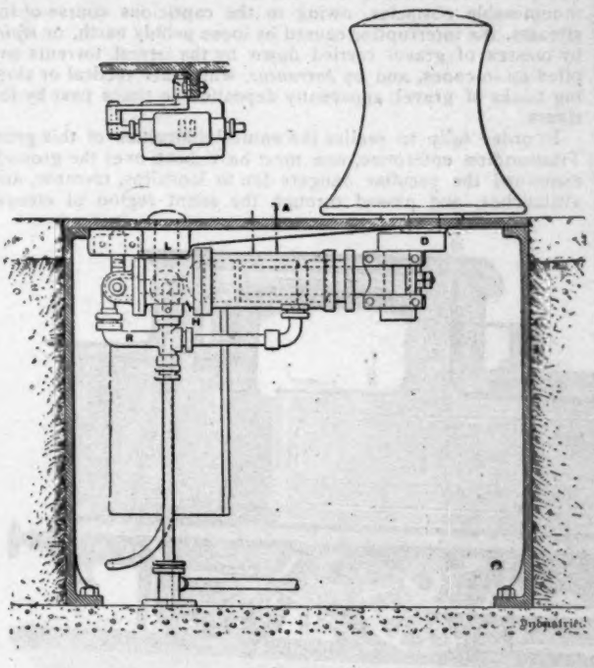
The Westinghouse brake is fitted to the four rear driving wheels. A sanding apparatus is provided, and also an injector for washing the rails.

Transmission of Power by Electricity.—Siemens pointed out that no further loss of power was involved in the transformation of electrical into mechanical energy than is due to friction, and to the heating of the conducting wires by the resistance they oppose, and showed that this loss, calculated upon data arrived at by Dr. John Hopkinson and by himself, amounted at the outside to 38 per cent. of the total energy. Subsequent careful researches by the Brothers Hopkinson have demonstrated that the actual loss is now much less than it was computed at in 1885; as much as 87 per cent. of the total energy transmitted being realizable at a distance, provided there be no loss in the connecting leads used.

Hydraulic Capstan Engine.—The accompanying illustrations represent Gallon & Chapman's patent hydraulic engine for working capstans or other machinery, as applied to two capstans at the Albert Dock, Leith, fig. 2 being an elevation and fig. 3 a plan. The engine was built by Hawthorne & Company, Leith, Scotland.

It consists of two double-acting oscillating cylinders *C C*, placed at about right angles to each other, with piston-rods *E E*, attached direct to a single crank *D*, of which the pin is long, with a gun-metal bearing. The cylinders are lined with brass, and oscillate through a few degrees only, the oscillating block *H* being carried by two long bearing-pins *L*, which pass

Fig. 1. Fig. 2.



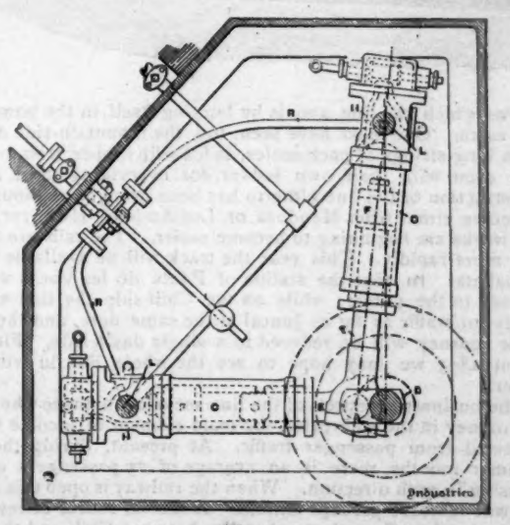


Fig. 3.

through bosses on the bed-plate. The pistons *F F* are fitted with hemp in preference to leather packing. The slide-valves and faces are of extra hard gun-metal, the valves being controlled by a single or double link so that they cannot be displaced. Fig. 1 shows a detailed view of the slide-valve link. The main pressure-pipes *R R R* oscillate slightly when they are packed by means of a stuffing-box and gland, ample space being provided to permit of the operation of packing. The starting is effected by means of a lever *A*, placed so as to be readily worked by the operator, and an adjustment arrangement is provided to regulate the speed of the capstan. The fewness of working parts and their simplicity ensure continuity of work with minimum attention and overhauling. In fact, one of these engines and capstans has been successfully at work for upward of two years.—*Industries.*

The Work of the Naval Engineer.—The *Spectator* has an article headed "What Our Naval Engineer Must Do," which seems to be suggested by a recent correspondence in the *St. James's Gazette.* The writer points out that whereas a ship like the *Rattlesnake* has five lieutenants and one sub-lieutenant, she has only one engineer officer, which, it is argued, is by no means sufficient. When anything goes wrong with the machinery or gear, the solitary engineer officer has to spend very many hours on duty, although when things have settled down he may, if he likes, leave the supervision to an "artificer," who is paid £2 a week to take command of the engines of a ship which cost £200,000. He has the permission of the late Second Naval Lord for doing this, and that high authority has expressed himself "perfectly satisfied" with the arrangement; so he has no right to be critical. At the same time, he naturally feels uneasy at leaving to a workingman the charge of engines of 3,000 H.P., together with the pumping engines, and the electric-light engines, and those for hoisting in the boats, with the steam-steering gear and the two steam pinnaces, in addition to a "watching brief" for guns large and small, which the men can put out of order at the "shortest notice" and "the least possible delay." Yet these are by no means a full list of what were described before the Committee on Naval Estimates as "the comparatively simple duties of an engineer officer."

Geographic Names.—The Board on Geographic Names, appointed by the heads of departments in Washington, has been formally constituted by the following order from the President:

"As it is desirable that uniform usage in regard to geographic nomenclature and orthography obtain throughout the Executive Departments of the Government, and particularly upon the maps and charts issued by the various departments and bureaus, I hereby constitute a Board on Geographic Names, and designate the following persons, who have heretofore co-operated for a similar purpose under the authority of the several departments, bureaus and institutions with which they are connected, as members of said Board: Professor Thomas C. Mendenhall, U. S. Coast and Geodetic Survey, Chairman; Andrew H. Allen, Department of State; Captain Henry L. Howison, U. S. N., Lighthouse Board, Treasury Department; Captain Thomas Turtle, Engineer Corps, War Department; Lieutenant Richardson Clover, U. S. N., Hydrographic Office, Navy Department; Pierson H. Bristow, Post Office Department; Otis T. Mason, Smithsonian Institution; Herbert G. Ogden, U. S. Coast and Geodetic Survey; Henry Gannett and Marcus Baker, U. S. Geological Survey.

"To this Board shall be referred all unsettled questions concerning geographic names, which arise in the Executive Departments, and the decisions of the Board are to be accepted as the standard authority in such matters.

"Department officers are instructed to afford such assistance as may be proper to carry on the work of this Board.

"The members of the Board shall serve without additional compensation, and its organization shall entail no expense upon the Government."

Lieutenant Richardson Clover, U. S. N., has been chosen Secretary of the Board, and all communications intended to reach it should be addressed to him.

Influence of the Rotation of the Earth on Moving Bodies.—In an article published in the *Zeitschrift* of the German Engineers' Union, Herr T. Von Bavier says that it has often been observed that in railroad lines running north and south there occurs, in course of time, an appreciable displacement of the rails, always more noticeable on the right-hand side. This is, as the author remarks, chiefly due to the effect of the rotation of the earth on its axis, the normal condition being that with a train traveling in such a direction and equally loaded there is a greater pressure on the right-hand side than on the left.

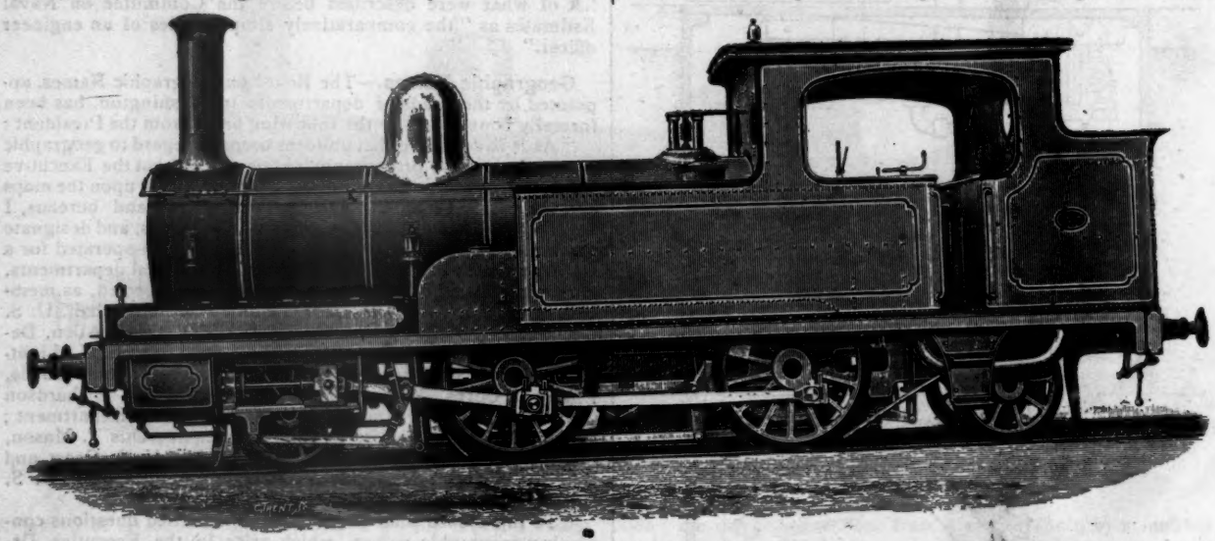
In N. latitude 51° a man weighing 165 lbs., running at the rate of 13 ft. per second from north to south, sustains a horizontal pressure toward the east equal to 54 grains, which, acting at the center of gravity of the body at say 3 ft. 3 in. above the ground, necessitates an extra pressure on the right foot of 0.63 oz., in order to maintain the vertical position of the body. In going from south to north the proportion is the same; in the southern hemisphere the extra pressure would come on the left side. With varying directions the force is, of course, proportionately varied.

In the case of an express train, weighing say 400 tons, traveling northward at the rate of 50 miles an hour, the extra pressure on the right-hand or eastern rail amounts to 501 lbs., the same

pressure coming on the right-hand or western rail when traveling in the reverse direction. In more northerly parts the lateral force increases, reaching its maximum at the North Pole, in which region, in a case similar to the preceding, the extra pressure on the right-hand side would be 660 lbs. In the large ocean steamers the force is considerably greater; the side-pressure on the Inman liner *City of New York* being about 936 lbs. The tendency of this lateral pressure would be to drive the vessel (if on a northward or southward course) somewhat to the east, so that to keep on a prescribed course requires a slightly increased engine power to overcome the tendency to deviation. This increase is, however, not more than $\frac{1}{10000}$. Such as it is, it is inappreciable on the east and west run between Liverpool and New York; but would be distinctly perceptible in a voyage from Liverpool to Buenos Ayres.

A Tank Locomotive for Japan.—The accompanying illustration shows a tank locomotive built for the Sanyo Railroad in Japan by the Vulcan Foundry Company, of Newton-le-Willows, England; it is from the London *Railway Engineer*.

The engine has four coupled wheels, with bearing wheels in front and behind the fire-box, the bearing axles being fitted with radial axle-boxes. Water is carried in two side tanks and a smallr ear tank, and coal in a box placed on an extension of the frames behind the fire-box. The tanks have a capacity of 1,000 gallons of water, and the coal-box 45 sq. ft.



The gauge of the engine is 3 ft. 6 in. The driving wheels are 52 in. in diameter, and the leading and trailing wheels are 37 in. The cylinders are 14 in. in diameter and 20 in. stroke; they are placed outside and have the steam-chests on top. The valves are worked by Joy's valve gear, placed outside, as shown in the engraving. The grate area is 12 sq. ft., and the heating surface is: Fire-box, 70; tubes, 654; total, 724 sq. ft.

The total weight of the engine in working order is 78,400 lbs. It is fitted with driver brakes. The cab is of sheet iron and has a double front, as shown, the engine being intended to run in either direction, without turning.

The Transandine Railroad.—The originators of this line are J. E. & M. Clark & Company, who obtained in 1873 the first concession of a line from Buenos Ayres to the Pacific, passing through Villa Mercedes, Mendoza, and through the Uspallata Pass to the Chilian frontier, with a branch from Mendoza to San Juan. Owing to financial and political difficulties, this general combination was not carried out. About 1880 the Argentine Government built the section from Villa Mercedes to Mendoza and San Juan. In 1883 Clark & Company built the Pacific line from Buenos Ayres to Villa Mercedes, which has since passed into the hands of an English company, while the line from Villa Mercedes to Mendoza has also become the property of an English company, the Argentine Great Western. The actual works of the Transandine line were begun in 1887 by an English syndicate called the Buenos Ayres & Valparaiso Transandine Railway Company, which bought the concession from Clark & Company, and is building the line on the Argentine side, with Clark & Company as contractors. On the Chili side, from Los Andes to the frontier, the line is being built by Clark & Company, under the title of Clark's Transandine Railway. Thus, when the route is finished, it will run over the rails of five different companies between Buenos Ayres and Valparaiso, namely, the Pacific, the Argentine Great Western, the Buenos Ayres & Valparaiso Transandine, Clark's Transandine, and lastly the Chilian State line, from Los Andes to Valparaiso

The first studies for the mountain line were made in 1873, but a serious survey was not completed until 1887, amid countless difficulties, for the ground was almost entirely pathless and unknown both geographically and geologically. Up to the present day you find no maps and no literature about this section of the Andes. The field is new and open to future enterprise. The point at which the Cordillera is to be passed is situated in the Cumbre between the two lofty snow-clad peaks of Tupungato toward the south and Aconcagua toward the north. From the Chili side the line winds along the terraced mountains of the valley of the Aconcagua River; from the Argentine side the valleys of the Mendoza and Cuevas rivers are followed amid innumerable obstacles, owing to the capricious course of the streams, the interruption caused by loose pebbly earth, or *ripio*, by masses of gravel carried down by the lateral torrents and piled up in cones, and by *barrancas*, which are vertical or sloping banks of gravel apparently deposited in times past by the rivers.

In order fully to realize the natural difficulties of this great Transandine enterprise, one must have been over the ground, examined the peculiar dangers due to landslips, torrents, and avalanches, and passed through the silent region of eternal snows which the line avoids by burying itself in the bowels of the earth. One must have seen, too, the mountain-side dotted with long strings of pack-mules, laden with timber, iron, bricks, and even with their own fodder, for everything used in the construction of the line hitherto has been brought by thousands of mules either from Mendoza or Los Andes. However, now the works are beginning to become easier. The rails are being laid more rapidly. This year the track will be available up to Uspallata. In 1891 the station of Punta de las Vacas will be opened to the public; while on the Chili side the line will be ready for traffic as far as Juncal at the same date, and thus the mule journey will be reduced to a single day's ride. Finally, about 1895 we may hope to see the whole line in working order.

The business prospects of the line seem fair to those who have put money in the enterprise, the main element of income being expected from passenger traffic. At present, during the five summer months, there is an average of 25 passengers a day crossing in each direction. When the railway is open this number will increase perhaps tenfold. A second source of revenue will be local traffic and merchandise between Chili and the Argentine provinces of Mendoza, San Juan, and San Luis. A third element of profit is looked for in the transport of cattle from the Argentine to Chili. At present some 40,000 to 50,000 head are driven over yearly by the Uspallata Pass, and arrive in Chili mere skeletons. These cattle have to be fattened in Chilan *potreros*, where pasture is very dear; whereas, by the line, they can be carried over fattened and ready for killing. Fourthly, it is hoped that mines will be discovered and worked in the region opened up by the railroad. As for general merchandise and imported goods, the Transandine will not be able to compete with steamboat freights, and therefore the port of Valparaiso will retain all its importance.—*Theodore Child, in Harper's Magazine.*